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DISRAELI KOBAK, M.D., Editor

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## SHORT WAVE DIATHERMY POWER ABSORPTION AND DEEP TISSUE TEMPERATURE \*

E. MITTELMANN, E.E., Ph.D., S. L. OSBORNE, Ph.D.

and

J. S. COULTER, M.D.

CHICAGO

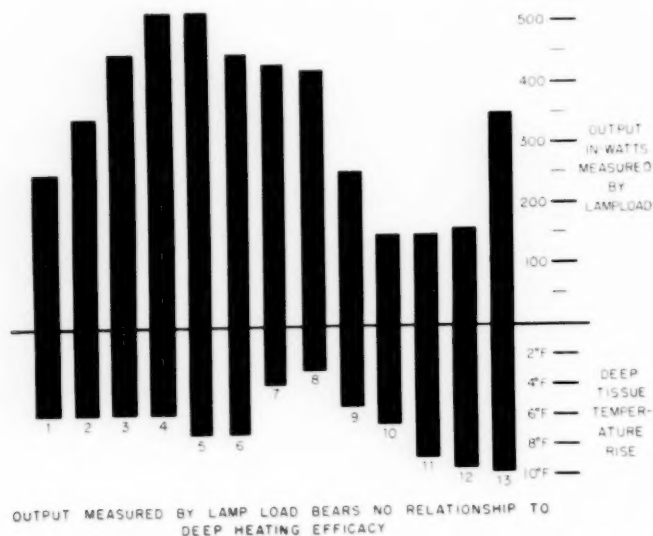
Although short wave diathermy has been in wide use for ten years or more, many basic problems of effective treatment have not been solved. Some contradictory statements in medical literature can be partially explained by the fact that investigators were unable to make quantitative statements on the power absorbed in the tissues during treatment. It is entirely a matter of chance what results might be achieved in a quantitatively uncontrolled experiment when more or less complicated functions are involved. Many data have been published as proof of the selective and specific properties of the various wavelengths investigated, but their validity is open to serious doubt.

Short wave diathermy produces heat within living tissues. Every object placed in a high frequency field will absorb a certain amount of energy, the magnitude of which depends upon the electrical properties of the object and its geometrical position in the field. Under all circumstances this energy is converted into heat. The heat generated in the tissue is directly proportional to the energy absorbed. Therefore, before a quantitative determination of the tissue heating can be made, it is desirable to know the actual amount of energy absorbed by the tissues subjected to the high frequency current. Short wave generators have been placed on the market with variable outputs. Manufacturers' advertising would lead one to believe that the greater the output the greater the possibility of heating the deeper tissues. The outputs so claimed were measured by methods selected by individual manufacturers which seldom bore a relationship to the actual working conditions. The Council on Physical Therapy of the American Medical Association, therefore, decided to test machines according to their ability to heat the deep tissues of the human body. The first report of this work was published in 1935, by Mortimer and Osborne.<sup>1</sup> That there is no relationship whatever between the magnitude of the deep tissue temperature and the total wattage output of the machine is clearly shown in figure 1. Studies since published<sup>2-4</sup> point to a similar conclusion.

Obviously the actual heating of the tissues will depend on the number of calories which are supplied to the tissues per second. Calories per second can be expressed as a unit of power—one watt equals 0.239 calories per second. By measuring watts, the amount of high frequency power absorbed and converted into heat in the patient's body, a quantitative measure for treatment is obtained. This power is usually but a fraction of the total high frequency power yielded by the short wave generators measured by a lamp load. The actual power absorbed by the patient is not always in the same proportion to the total actual output, but its share depends upon the technic of application. To measure the actual power absorbed by the patient during treatment a suitable measuring instrument has been designed by one of us,

\* Aided by a grant from the Council on Physical Therapy of the American Medical Association.

\* From the Department of Physical Therapy, Northwestern University Medical School.



OUTPUT MEASURED BY LAMP LOAD BEARS NO RELATIONSHIP TO DEEP HEATING EFFICACY

Fig. 1.—Graph showing there is no direct relationship of high frequency power output as measured by lamp load to temperature rise in the deep tissue of the thigh.

(E. M.).<sup>5-6-7-12</sup> By means of this instrument, it is possible to measure the power absorbed by the patient. Extensive tests by various workers<sup>7-8-9-17-22</sup> and repeated measurements of our own indicate that the accuracy of these measurements is within an error limit of 5 per cent. Details of the theory of operation and construction of this instrument have been published elsewhere.<sup>5-7-17</sup> Thus far clinical investigators<sup>7-8-9-16</sup> have been concerned with the relationship of power absorption and the subjective heat sensation of the patient during localized treatments or the pulse rate changes in the course of treatment.<sup>10</sup> Clinical data presented by Kowarschik<sup>8</sup> and Weisz<sup>6</sup> resulting from their experience over a period of two years would seem to indicate that provided a certain technic of application is maintained, the power absorbed by the patient is a guide for the repetition of treatments with like heat sensations. Under such conditions similar power absorption will cause similar degrees of heat sensation in different individuals. But, as pointed out by Rajewsky,<sup>11</sup> some objections might be raised against any generalization of these tests. The heat sensation is limited to the heat on the surface. It is possible, therefore, that different temperatures might be secured in the deeper tissues although the sensation of the skin surface is kept constant. Such may be the case for instance with air spaced electrodes of different diameters applied at various distances from the skin.

In the course of the tissue heating experiments it was found that the maximum tissue temperature was not always reached at the termination of the usual twenty-minute period. It was found by taking temperature readings every five minutes that the maximum temperature frequently was reached at a period of ten to fifteen minutes, after which there was a leveling off and decrease in tissue temperature. This offered a possible criticism of the present method used in testing short wave generators by taking final temperatures as a criterion. This leveling off and decrease from the maximum tissue temperature is due to marked changes in the local circulation. Both blood volume and velocity are increased which results in a variable dissipation of heat. Thus, by taking the final tissue temperature at the end of the twenty-minute period as a criterion for classifying machines, a good apparatus might be rated lower than one which in reality is less efficient.



Therefore, the present investigation was undertaken to ascertain whether or not some simple relationship exists between the power absorbed by the patient and the degree of heating in the deeper muscular tissues. If such a relationship exists, it should be a simple matter to determine the maximum output necessary for clinical applications. Measurements earlier reported by one of us, (E. M.),<sup>5-12</sup> Wenk<sup>13</sup> and others<sup>15-16</sup> indicate that the maximum values of power absorption which could be administered in local treatments within the limits of the patient's tolerance are in the order of magnitude of 100-150 watts. A solution of this problem is essential because some manufacturers and physicians are insisting that an increased wattage output for these generators is necessary to produce effective treatment.

### Methods

Short wave generators of 6, 8, 12 and 24 meter wavelengths designed by different manufacturers were used in our experiments. In the high frequency electric field (condenser field) air spaced, double cuffs, and condenser pads were used for the applications. For the electromagnetic field the induction cable was used either in the form of a pancake coil, disk electrode or wound around the part to be treated. Ninety-six tests were made. The same wattmeter was used in all experiments. Preceding each series of tests the calibration of the wattmeter was carefully checked by a calorimetric test. A detailed procedure of calibration has been described elsewhere.<sup>17</sup>

Healthy, male students were selected as subjects for the tests. As a rule the same machine was used in the same series of measurements. No more than six observations, each of twenty minutes' duration, were made alternately on each individual under test. A time of 30 to 40 minutes was allowed between consecutive tests to permit sufficient cooling of the subject prior to the next series of measurements. The power absorption measured by the wattmeter was kept constant during the entire course of each twenty-minute experiment.

Deep tissue temperature measurements were made by a method described by one of us (S. O.) elsewhere.<sup>1</sup> Continuous readings were not possible due to the effect of the high frequency current on the measuring apparatus, but measurements were made at intervals of five minutes while the current from the short wave generator was turned off. Approximately thirty or forty seconds were lost each time a reading was made. This introduced a slight error in the values recorded, when the temperature rise is plotted as a function of exposure time. Due to the high thermal capacity of the muscular tissues the error probably did not exceed  $\pm 5$  per cent. The temperature drop per minute during the period in which the current is switched off, will depend upon the actual value of the tissue temperature. Measurements of the cooling curves indicated that the temperature drop per minute in the deep tissue varies between 0.25 F. at a temperature of 106 degrees and 0.05 F., per minute at 102 degrees and below. The error due to the time loss is within the limits of the accuracy of the temperature readings with the potentiometer equipment, namely  $\pm 0.04$  F.<sup>4</sup>

The approximate volume of the thigh mass to be heated was computed from the thigh circumference at the upper and lower end of the electrodes and the distance between them. By this means the theoretic temperature values were computed and checked with the actual temperature obtained. The standard clinical applications were used throughout the tests.

### Results

The results of 11 tests made on two subjects using a short wave therapy generator of 24 meter wavelength and the technic of electromagnetic

TABLE 1. — *Relationship of Temperature Rise Per Minute to Power Absorption.*

	No.	Power Absorbed Watts	Temperature Rise Per Min.	Watts Per 1000 cc. for 0.1 F. Tempera- ture Rise Per Min.	Deviation Against Average, Per Cent.
Subject I Thigh Mass Approximately 3800 cc.	1	60	0.275	5.75	— 1.
	2	72	0.310	6.15	+ 4.8
	3	74	0.300	6.42	+ 8.
	4	85	0.384	5.86	0.
	5	86	0.390	5.78	+ 0.7
	6	100	0.460	5.75	+ 0.7
	7	137	0.652	5.55	+ 5.2
Subject II Thigh Mass Approximately 3280 cc.	8	88	0.440	6.15	+ 4.8
	9	88	0.440	6.15	+ 4.8
	10	44	0.2600	5.20	—13.
	11	135	0.720	5.75	— 0.7
Average of all tests.....				5.86	

induction are shown in table 1. The tests were made alternately on each subject. This table shows the relationship between the power absorption and the temperature rise per minute. The rise in temperature is proportional to the actual value of the power absorbed. The values in column 4 (watts per 1000 cc. for 0.1 F. temperature rise per minute) were computed from the values actually measured and recorded in columns 2 and 3 and from the thigh volume.

The actual results obtained agree well with the theory. The amount of power absorption required per unit tissue volume, to raise the tissue temperature to a certain extent, in a given time, is the same in all tests. The deviations against the average are well within the limits of the permissible experimental error.

Figure 2 was plotted from the data of measurements taken when using different wavelengths and various technics. In all curves the temperature rise per minute is strictly proportional to the value of the actual power absorbed by the patient. A deviation from the linearity takes place only toward the end of the 20-minute period in cases when the values of power absorption exceed 100 watts, or the subject has been treated a short time previously (curves with index 2 in fig. 2).

The amount of power absorption which is necessary to raise the temperature of 1000 cc. thigh volume by 0.1 F. per minute was again computed from the results plotted in figure 2 and recorded in column 6 of table 2. The averages in tables 1 and 2 are practically identical, proving again the proportionality between temperature rise and power absorption.

Some claims<sup>21</sup> have been made that current measuring devices (ammeter) used with short wave machines provided with bare metal electrodes are reliable indicators for patient dosage. Six series of measurements were made with this type of machine of 12-meter wavelength. Two individuals of about the same weight and with similar thigh dimensions were selected for this test. The dose given in each instance according to the high frequency ammeter was identical for both subjects. Results of these measurements are shown in figure 3. It may be clearly seen that treatments with the same current intensity do not lead to the same temperature rise. This difference is explained on the basis of the different electrical properties of the two individuals. Therefore, the same current value is not necessarily accompanied by identical values of power absorption in two different individuals. Hence with the same current, a difference of temperature results despite identical thigh volumes.

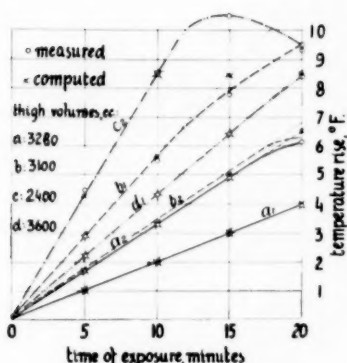


Fig. 2. — Heating curves showing temperature rise is proportional to power absorbed. (See table 2.)

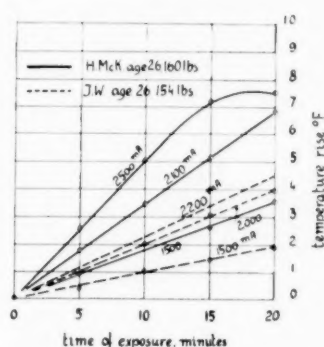


Fig. 3. — High frequency ammeter in series with bare metal electrodes. Two individuals with identical thigh dimensions were treated with similar current values as indicated. Heating differences are due to the different electrical properties of the individuals.

TABLE 2. — Heating Curves Obtained on Four Different Subjects Using Variable Wattages, Different Techniques and Various Wavelengths.

Volume cc.	Curve	Wavelength Meters	Technic	Power Absorption Watts	Watts Per 1000 cc. for 0.1 F. Temperature Rise Per Minute	Deviation Against Average, Per Cent.
3280	a1	6	Air Sp.	35	5.35	9.
3280	a2	6	Air Sp.	63	5.83	0.
3100	b1	12	Air Sp.	110	6.25	6.2
3100	b2	12	Air Sp.	70	6.60	11.0
2400	c2	12	Pancake Coil	115	5.68	3.0
3600	d1	8	Db. Cuffs	80	5.35	9.0
Average of all tests.....					5.83	

### Discussion

Many investigators claim that there is a selective heating based on wavelength. That this is not the case can be shown from theoretic and experimental considerations.<sup>1-19</sup> The claims for selective heating were based mostly on the erroneous assumption of a current of constant amplitude. This is an arbitrary assumption which cannot be realized in practice. Constant current amplitude does not mean constant power. Depending upon the electrical properties of the tissues, the same current intensity may result in different values of power absorption and hence different temperatures.

For the first time measurements have been made of the actual power absorbed and the temperature rise in the deep tissues of human subjects using variable techniques of application and wavelengths. The temperature curves indicate that the degree of deep tissue heating is dependent solely on power absorption and not on wavelength for similar ratios of deep heating to superficial heating. The investigations of Malov<sup>20</sup> with *Drosophila* agree with these experimental findings.

There is a marked difference in the behavior of the temperature curves for high and low wattage. Usually as long as the power absorbed does not exceed approximately 100 watts, the temperature in the deep tissue rises along a straight line until near termination of the twenty minute period. If the power absorption exceeds values much over 100 watts then the final temperature is actually lower than in the previous instance, probably due to the increased blood circulation rapidly dissipating the heat. The degree of deviation will depend upon the actual value of the increased blood flow.

According to the results of this investigation, the induction cable and the double cuff electrodes give practically the same temperature rise per minute and per watt in the thigh. In both cases virtually the total power is absorbed in the deep tissues of the thigh which are well insulated from thermal loss by the fatty tissues. For other parts of the body the ability of the cuff technic to produce comparable heating depends on the matching of impedances. On the other hand, if pad electrodes or air-spaced electrodes are used, deviation from the straight line occurs earlier.

Frequently when using the condenser field technic the subject would indicate that he noted a sensation of marked heat, yet the wattmeter indicated that the amount of power absorbed was low. In these instances it was found that the temperature rise showed a marked deviation from the lineal rise giving a final low temperature in the deep tissues. Thus, the reading on the wattmeter gives a fair estimate whether or not heat is secured deep in the tissues. Our experiments showed that a high temperature sensation accompanied with low power absorption is an indication of a low temperature in the deep tissues. In these instances a large part of the power is absorbed on the surface, causing the high temperature sensation, while but a fraction of the power reaches the deeper tissues. On the other hand, a comfortable heat sensation and a simultaneous relatively high power absorption indicate that a larger fraction of the power is absorbed in the deep tissues. As may be seen from the temperature curves presented, the absorption of 80 watts in local treatments can produce temperature elevations of 8 to 10 F., which correspond to a final temperature of approximately 106 F. and 107 F. If the wattage is increased the final temperature is not necessarily higher, as already pointed out. It seems that the maximal temperature which can be secured averages 107 to 108 F. A rise above this temperature is prevented by increased thermal regulation. This opinion is supported by the fact that this maximal temperature can be reached with entirely different values of power absorption (fig. 2). The values obtained for the power absorbed are in agreement with the published measurements made by others.<sup>7-8-13-14-15-16</sup>

A rough estimate of the power necessary to produce hyperpyrexia shows that fever therapy can be administered with machines of relatively small output. In our clinic we use an air conditioned cabinet in conjunction with electromagnetic induction for the production of fever and during several treatments the power absorbed by the patient was measured. In no instance did the actual power absorbed by the patient exceed 160 watts. For such treatments the average temperature rise is about 1 F. each 15 minutes. Let us assume that the caloric value of a subject weighing 70 kilograms is approximately equivalent to 70 kilograms of water. If we compute the amount of power necessary to raise the temperature of this volume of water 1 F. each fifteen minutes, we find that the power necessary to accomplish this is of a similar magnitude — 160 watts.

### Summary

1. Measurements of power absorption were made with a high frequency wattmeter with an average accuracy of plus or minus 5 per cent.
2. It was found that the temperature rise in the deep tissues per minute was proportional to the number of watts indicated by the instrument.
3. Temperature rise is linear for wattages below 100 watts of power absorbed. Wattages above 100 watts, however, produced a non-uniform rise toward the end of the treatment, due probably to the marked increase of blood flow. Therefore with high wattages the final temperature attained

at the end of a twenty minute period is not a true measure of the machine's heating ability.

4. The average value of useful power for local application was between 50 to 80 watts.

5. Measurements indicated that 150 to 160 watts was the maximum power which can be utilized by human tissues. This amount of power was sufficient for effective fever therapy.

6. The useful power or that absorbed by the patient is but a fraction of the total output of the machine as measured by lamp load. There is no justification for the use of generators yielding more than 200 watts of useful power. The ratio between total and useful power is dependent upon machine design and technic of application.

7. The effectiveness of tissue heating in vivo is independent of wavelength.

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## SIDE EFFECTS OF SHORT WAVE THERAPY AND THEIR PREVENTION \*

HEINRICH G. BRUGSCH, M.D.

Instructor in Medicine, Tufts Medical School

BOSTON

During the short period of ten years since Schliephake first administered short wave diathermy to patients the clinical application of short wave apparatus has grown rapidly. Mathis<sup>1</sup> has recently stated that more than thirty thousand are in use in this country. If his statement is correct, then it is obvious that some are operated by untrained or unqualified persons.

In view of this widespread use it is important to emphasize certain side effects which, in the hands of the inexperienced, may lead to dangerous consequences. Furthermore, the study of certain of these side effects may permit us a wider, so to speak, more complex view on the effects of short wave therapy upon the human organism. Finally, I hope that this survey will stimulate further studies in a field which as yet has found little attention. My experience covers five years in which more than twelve thousand treatments have been given with various wavelengths and electrodes. These treatments do not include artificial fever. Side effects involving the whole organism were first observed by Whitney<sup>2</sup> in 1928, who noticed that workers on short wave radio transmitters complained of certain disagreeable symptoms, such as severe headache, irritability, restlessness, lack of sleep, and depression. This was later confirmed by Bell and Ferguson.<sup>3</sup> Schliephake<sup>4</sup> summarizes similar experiences as follows:

The complaints of individual persons vary according to individual susceptibility. Some complain of disagreeable sensations immediately after the starting of the apparatus, others have discomfort at the end of their daily work after several hours' operation of the unprotected transmitters. Most of the sensations are localized in the head. The first thing noticed is a peculiar drawing sensation in forehead and skull. This sensation is so marked in some persons that on entering the therapy room they are immediately able to tell whether the machine is in operation or not. After a prolonged stay in the therapy room, marked fatigability takes place as a rule, which may increase to a state of apathy if proper protection is lacking. Finally, certain symptoms of psychoneuroses are noticeable, such as restlessness, excitability, sometimes depression, and a pessimistic attitude. In the evening they have difficulty in falling asleep and are easily awakened. In the morning they are tired out, listless, and languid. On further exposure, a dull pressure upon the head and headaches are noticed, which may increase until they become unbearable.

All this, according to Schliephake, occurs much more noticeably in work with wavelengths below 10 meters. I quoted Schliephake's report because similar observations have since been made by Cholnoky<sup>5</sup> and others. That there is individual susceptibility is demonstrated by the fact that I have worked for five years with short wave machines without any disagreeable symptoms, while a colleague, who has the same type of apparatus, immediately noticed signs of irritability, restlessness, and headache so long as he was in rooms where this machine was operating. However, ten years of intensive work with short wave apparatus has not led to any claim of permanent damage due to exposure. In claims by employees this susceptibility should be noted as well as the fact that after termination of operation of the machine the symptoms disappear. The use of specially designed garments or

\* Read at the Nineteenth Annual Session of the American Congress of Physical Therapy, Cleveland, Ohio, September 5, 1940.

screens has been advocated, but so far as I can learn this has not been given serious attention in this country.

### General Side Effects

In patients such generalized symptoms are much less likely to occur since their exposures to short wave energy are usually of short duration and spaced far apart. Chohnoky, however, saw such disagreeable side effects that he had to discontinue treatment in some cases. Patients of more advanced age are undoubtedly liable to slight discomfort after exposure to strong heat or prolonged treatments. The symptoms are dizziness, sweating, and pallor of the skin, occasionally followed by faintness. On physical examination increase in pulse rate and decrease of blood pressure will be found. Only in patients with marked symptoms does interruption of treatment become necessary. If the treatments are given to the patient while he is in a semi-reclined position, the symptoms are usually less marked. Treatment through the head is particularly apt to produce dizziness and a tendency to syncope.

Another general effect of short wave treatment is a tendency to fall asleep. This is especially common among nervous persons and children. In such patients the danger of burns is naturally great and every effort should be made to keep the patient awake.

Numerous studies have been made to determine the response of the blood and of the body fluids to short wave radiations. Leaving aside those made on animals as of little value for our purpose, we are left with a certain amount of information which, in itself valuable, is still insufficient to give us a complete and true picture of the changes produced in the blood and body fluids of the living human body. A few reports, however, are worth mentioning here. Kobak<sup>6</sup> has shown that the blood sedimentation rate increases shortly after exposure to short wave. In special arrangements for radiation of infected granuloma, Gutzeit and Kuechlin<sup>7</sup> and Liebesny<sup>8</sup> have claimed that increase of the sedimentation rate following exposure to short wave indicates an active focal infection. Recently Pfankuch and Karpf<sup>9</sup> have checked these claims and were unable to confirm them, since even exposure of normal teeth led to an increase in the blood sedimentation rate of about 20 per cent. My personal experience has shown that successful treatment with short wave decreases a fast sedimentation rate. The same holds true with the slight increase of leukocytes observed shortly after treatments. As soon as the condition causing leukocytosis improves, the white count returns to a normal value. Careful studies of the behavior of the blood on a large series of patients under normal and pathologic conditions are still lacking. They would undoubtedly be of great value. The response of the blood sugar curve has been studied by a number of investigators. Increase as well as decrease of the blood sugar has been found. Unfortunately, these curves were obtained with quite different exposures and different technics and are, therefore, not comparable. We have observed four patients with diabetes who, shortly after short wave was applied to the neck for furuncles, showed a definite increase of the sugar in the blood and urine.

In view of the tendency to collapse and vasodilatation observed after short wave therapy, recent experiments by Hildebrand<sup>10</sup> are worth mentioning, because he found that histamine increased more than 100 per cent in the blood of dogs after exposure of the lungs to short wave radiations.

Increase in proteins and flattening of abnormal gold Sol curves of the spinal fluid in patients with schizophrenia after radiation of the skull was found by Haug.<sup>11</sup> This could not be substantiated by Duerler,<sup>12</sup> who used the same technic. Both, however, found that the permeability of the meningei

for bromides showed alteration. Liebesny<sup>13</sup> demonstrated marked vascular changes found at autopsy of some patients treated by short wave.

If we summarize the general side effects of short wave therapy, we can state that mild signs of vascular collapse may occur, perhaps due to the liberation of histamine, but that serious effects have not been observed. It is interesting that after-effects, such as are observed after x-ray therapy, have not been seen. Occasionally patients complain of excessive fatigue for the rest of the day and increased tendency to sleep.

#### Local Side Effects

Discussions and papers on short wave therapy usually culminate in the statement that this method is completely harmless. Considering the great number of treatments given daily not only by experts but also by persons with little experience, it is surprising that only a few accidents have been recorded. Local side effects are the direct sequences of heat upon the different organs. They are burns, hyperemia, and possibly certain changes of organs.

*Skin.* — The most obvious and most frequent side effects are found on the skin. Almost everyone who has treated a large number of patients has observed burns. These are usually of pin-point size, due to the accumulation of small droplets of sweat. Occasionally, however, burns of the second degree may occur. These have been reported by Schliephake at the margin of one ear; by Cholnoky at the back of the hand; and by Saidman.<sup>14</sup> In my own experience embracing 12,050 treatments given to 1100 patients, I saw three small burns and one slightly larger one covering an area of about one centimeter. The latter was due to accumulation of sweat under a coil. All healed promptly within a few days. Three most serious complications have been reported by Kling,<sup>15</sup> who saw altogether seven burns. The third-degree burns were caused from treatment by a salesman.

Hellwig<sup>16</sup> reported on the legal consequences of such a case, discussing the claims of a patient who suffered third-degree burns on a toe. In this case no supervision whatsoever was given after the treatment was started. From the statements of witnesses it is evident that this was common practice in that particular office and that some patients increased or decreased the power themselves, while others remained longer under the machine than was prescribed by the physician. The patient's claims were justly recognized by two courts.

The small number of burns in my series is undoubtedly due to the strict supervision made possible by air-spaced electrodes. The interposition of any material such as felt or towels will always increase the danger of unpleasant complications because it prevents supervision of the exposed area. In order to avoid damage claims it has to be stated here that very small burns are not always avoidable. They are without any importance for the well-being of the patient and heal quickly. The occurrence of larger burns, however, can and should be avoided. They are always due to either faulty material, for instance, rubber pads breaking along the margins, or improper application. It is not amiss here to repeat the warnings so frequently given not to overlook the possibility of anesthetic zones of the skin. I am thinking here not so much of the lesions due to disease of the spine, such as tabes dorsalis or syringomyelia but of peripheral nerve disturbances which may occur in arteriosclerosis, Buerger's disease, polyneuritis, or sciatic neuritis.

Leroy<sup>17</sup> is the only one who has observed the occurrence of a dry, scaling dermatitis in three instances, which cleared up within eight days after discontinuance of the treatment.

Another side effect is the hyperemia in patients who have to undergo certain surgical operations. Though hyperemia is our therapeutic goal, it may cause engorgement of the tissues to a degree as to render difficult the ligation of blood vessels and favor post-operative hemorrhages. We have seen this sequence in two patients with abscess formation where incision was made shortly after an exposure to short waves. In both instances this hyperemia was quite obvious and made the operation somewhat difficult. A similar observation on the pelvic organs has been noticed by Hackerman.<sup>18</sup> The most serious cases are reported by Eidinow<sup>19</sup> who claims to have seen two severe hemorrhages, one fatal, after short wave therapy to pelvic organs. It seems advisable, therefore, to have a certain period of time elapse between the last application of short wave and surgical intervention.

*Mucous Membranes.* — Slight burns have been observed after treating cavities by special electrodes. Such burns in the vagina have been reported by Gottesman and Schliephake. I observed two small burns within the oral cavity after application of electrodes introduced into the mouth. Both healed quickly. In using metallic rectal electrodes special caution has to be taken to prevent accumulation of moisture in the region of the external sphincter. I have seen one burn at this place and have since tried to protect this area by thick pads of absorbent material.

The effect upon internal structures and organs is obviously that of hyperemia since proper control of the skin temperature prevents the occurrence of necrosis and burns. Small infiltration in fat tissues may occasionally occur, probably due to local necrosis.

*Lungs.* — Special care has to be taken in exposing lung tissue to hyperemia. Strauch,<sup>20</sup> Lezius,<sup>21</sup> and Fiandaca<sup>22</sup> each have observed fatal hemorrhages occurring during treatment of patients suffering from lung abscess. In one of my own patients hemoptysis during the treatment forced me to discontinue the application of short wave for some time. The presence of blood in the sputum of its occurrence during treatment should certainly be considered as a contraindication to short wave therapy.

*Heart and Circulatory System.* — As mentioned above, the pulse rate increases and the blood pressure falls during the application of short wave. The effect of direct radiation upon the heart has been carefully studied during the last years since it has been used extensively in the treatment of angina pectoris. I have followed four patients with severe attacks of angina pectoris and myocardial damage due to old coronary infarction over a period of one-half to one year. The behavior of the blood pressure after initial irregularities showed a continuous decrease during treatments over the whole period. In no instance did attacks of angina occur during the actual treatments. This is important, since fatalities have been observed shortly after termination of the treatment (Liebesny).<sup>23</sup> A careful check upon the number of attacks during the interval did not show noticeable changes. One patient developed a fresh coronary infarction during the course of the treatment. Whether the fall in blood pressure is due to action upon the carotid sinus as Vannotti's<sup>24</sup> experiments have shown or due to the liberation of histamine is open for discussion. Unfortunately, this drop is not permanent and its application in treatment of essential hypertension has not been found of value, as recently shown by Hertzman and his co-workers.<sup>25</sup>

*Endocrine Organs.* — Menstrual disturbance in female workers with short wave machines has been observed by Bierman. Similar observations have been made on patients who were treated for pelvic inflammatory conditions (Gottesman,<sup>26</sup> Korb<sup>27</sup>). The most important question is concerned with the

response of ovaries and uterus from the point of view of pregnancy and fertility. Extensive studies carried out on the genetics of the *Drosophila* fly have not shown any damage to the progeny. In other experiments chicken eggs could be hatched by exposure to short wave with normal results. Though short wave radiation has been given without obvious damage to pregnant women, it is only fair to record one observation made by Heisler,<sup>28</sup> who reported that a woman treated extensively with short wave during the early months of pregnancy gave birth to a malformed child. In regard to the fertility of the male, no definite claims pro or contra can be made, since local treatment of the testis or prostate is usually given patients with definite disease of these organs, frequently of advanced age. Experiments on animals, however, reveal it as unlikely that damage to the spermatogenesis can be produced by therapeutic doses of short wave. The influence upon other organs which has occasionally been mentioned in the literature has not been substantiated. It seems that only prolonged exposure with doses large enough to produce definite hyperemia may lead to certain effects, such as increase in blood sugar after radiation of the adrenals or decrease in diuresis after radiation of the pituitary gland. Our knowledge on these phenomena, however, is very limited.

### Resumé

This review shows that local burns to the skin and mucous membranes occur and that their avoidance is one of the most important duties of the technicians. Complete unimpairment of the apparatus including cables and electrodes and the proper application of the latter are as important as continuous supervision of the areas treated and the immediate discontinuance of the treatment as soon as unwanted accumulation of fluid, sudden areas of redness, or blister formation occur. Observation of side effects on internal organs renders it imperative that short wave therapy should be given only by a qualified physician after a careful evaluation of the physical fitness of the patient. Only if the indications are clearly given and justified and if the known response of the organ exposed to short waves are clearly considered will the physician be fortified against claims which are more liable to occur with patients exposed to physical agents than in any other form of therapy except surgery.

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## EVALUATION OF PHYSICAL THERAPEUTIC MEASURES IN FACIAL PARALYSIS \*

RICHARD KOVÁCS, M.D.

NEW YORK

Facial paralysis is a problem of special interest to physical therapists. All clinicians are agreed that after dealing with the existing cause physical therapy is the main standby of conservative treatment. But they are not all agreed which form of physical treatment is the most desirable, and how early it should be instituted. In surveying the extensive literature an interesting variation in terminology is also noted. In most of the older articles and some medical dictionaries the terms Bell's palsy and facial paralysis are used interchangeably, for it was Sir Charles Bell, a noted Scottish physiologist and surgeon who in 1826, first described the now classic symptoms. In many other articles and in present day usage the term Bell's palsy is applied only to the peripheral type of facial paralysis and specifically to its most frequent form, that due to chilling or refrigeration. We will employ in this essay the term according to modern usage.

In dealing with a case of facial paralysis the first concern must be to establish an etiologic diagnosis and to localize the lesion. There are well defined symptoms of additional nerve involvement as the lesion is located proximally to the origin of the nerve. The primary and secondary pathologic changes in the nerve sheath and the trunk vary with the cause, such as cold, compression, severance or a toxic affection. The rationale of our therapeutic attempts must be based on the consideration of the pathologic changes, for which reason one must briefly discuss their prevailing conceptions.

### Pathology of Bell's Palsy

About 75 to 80 per cent of all cases of facial paralysis are due to environmental influences, principally chilling or draft, which accounts for the interchangeable term rheumatic facial paralysis. There are cases on record in which application of ice to the neck for tonsillitis brought on an attack of facial paralysis. Leiner<sup>1</sup> states that exposure of a side of the face to the play of a current of air (draft) leads to a rapid evaporation of the skin, with an accompanying superficial vasoconstriction and a simultaneous deep-seated congestion. As a result, the neurilemma of the nerve trunk becomes swelled and impinges upon the neuroaxial fibers because of the non-yielding bony constriction of the stylomastoid foramen. Cobb and Coggeshall<sup>2</sup> in a recent study reassert that exposure of the facial nerve brings on an edema that blocks the stylomastoid foramen and presses on the facial nerve. In an earlier study Clark<sup>3</sup> points out that the infrequency of pain in the peripheral nerve distribution and the absence of tenderness upon pressure in either the nerve or the muscles indicate simple degeneration of the nerve; passive movements of the muscles are not painful, as in neuritis. Consequently there are a few clinical as well as pathologic reasons to indicate that the lesion in the peripheral portion of the nerve in Bell's palsy is one of parenchymatous neuritis. "The clinical phases of recovery in refrigeration palsy have many points in common with those seen in reunited or severely compressed peripheral nerves occurring elsewhere in the body."

\* Read at the Nineteenth Annual Session of the American Congress of Physical Therapy, Cleveland, Ohio, September 5, 1940.

### Is Early Treatment Indicated?

These generally accepted views on the etiology and the pathologic changes in Bell's palsy should render the desirability of early and effective physical treatment well understandable. It would seem logical to apply such physical measures to or around the affected portion of the nerve which would speed up the circulation and promote the absorption of the edema affecting the nerve. It is evident that if the pressure on the nerve trunk is diminished or fully relieved by such "decongestive" measures, secondary parenchymatous involvement with electric subsequent reaction of degeneration and a prolonged period of recovery can be avoided. Yet there are clinicians,<sup>4</sup> who, basing their opinion on the analogy of a peripheral nerve injury, advise for early treatment nothing but absolute rest by strapping or some other elastic support, plus gentle heating to the affected side. In addition, a few authors specifically emphasize that "electricity" never should be employed in the early stage.

The advice that no treatment except rest should be given until the ten day period for the possible development of the degenerative nerve changes has passed, would remind one of a fire brigade carefully watching a fire which just begins to smolder and standing ready to attack it as soon as the flames have fully enveloped the house, but not a minute earlier. Against such advice stand the conception of the pathologic process as described above, and clinical experience extending back many years when even leeches and mustard plaster were found effective for the immediate treatment of Bell's palsy. It is true that quite a few patients will recover without any treatment whatever: the fortunate ones in whom spontaneous early absorption of the edema occurs. No early sign or symptom exists that would enable one to foretell whether or not there will be such a recovery, because even with slight paralysis there may later occur a full-fledged nerve degeneration. Accordingly, by all considerations early effective "decongestion" by physical means seems well advised.

### Decongestive Measures

The average physician must feel somewhat bewildered by the variety of physical measures recommended for early treatment of Bell's palsy. They include thermal, mechanical and electrochemical agents. The fact that they all have been reported on favorably can signify only that when employed in sufficient dosage and frequency they all accomplish their main object, the improvement of local circulation with its subsequent relief of pressure from edema.

Thermal measures for early decongestion are: luminous heat, infra-red radiation, conventional and short wave diathermy. In view of present day experience the air-spaced technic appears safer and more convenient than plate contact, and is apparently equally effective. All of these measures unquestionably affect the circulation and metabolism of the treated soft structures of the areas, including the facial nerve and its sheath after its exit from the bony canal.

Electrochemical measures are recommended by clinicians here and abroad. Granger<sup>5</sup> lauds galvanism from the negative pole, at a strength of 5 to 15 milliamperes for twenty minutes. For pain he recommends ionization with 2 per cent sodium salicylate. After galvanism Granger advocates electrical stimulation with the interrupted galvanic current from the very beginning. Bourguignon and his followers are quite enthusiastic over ionization with a 1 per cent potassium iodid solution, applied from the negative pole not only to the side of the face but also along the external auditory canal through a cotton pack soaked in the solution. It is claimed that this method

acts more directly on the facial nerve. It is a justifiable assumption that electrochemical interchange of fluids and their ionic contents will result in an effect similar to that of thermal measures and thus help in the absorption of the local edema.

Mechanical measures for early treatment comprise the static wave current, the monoterminial high frequency or Oudin current, and manual massage. The static wave current applied with a crescent-shaped electrode in front of the ear offers the advantage of a two-fold effect: rhythmic mechanical action on the soft tissues underneath the electrode and electric stimulation of all muscles supplied by the facial nerve. In my hands and in those of many colleagues this method has proved the most satisfactory for many years. The chief drawback is of course the clumsiness of static apparatus and the fact that it has become less and less available in recent years. Other physicians, including the late Dr. King,<sup>7</sup> have employed the Oudin effleuve, which furnishes a combination of gentle mechanical action, mild heating and some counterirritation, without muscle stimulation. Manual massage as recommended by many clinicians is to be applied in the early cases only to the cheek in the form of gentle stroking. It undoubtedly exerts a relaxing effect, but it is not likely to affect the deeper circulation. If applied too vigorously, it will do harm.

Reviewing the physical agents recommended for early decongestion there appears to be a rationale for each of them. Hence it seems only a matter of convenience and individual clinical experience which one to select. To determine which of these measures is the most efficient would require a series of controlled observations, and no such data have been presented so far.

The pathologic changes in the traumatic, postoperative or toxic cases of facial paralysis vary according to their etiologic factors—hemorrhage or other mechanical effects leading to compression; partial or total severance; infection, extending from neighboring structures; virus diseases or metastatic infections, causing neuritis and ganglionitis. It is evident that in these cases there is no reason to proceed vigorously with endeavors to promote absorption of edema in front of the ear. The existing changes call for mild thermal measures to reduce inflammatory reactions, relieve pain if present, and to maintain a certain amount of physiologic rest. Efforts to preserve muscle function are equally indicated and will be discussed under electrical stimulation. The prognosis for recovery must be more guarded as it depends on the etiologic factor. An important guide will be obtained after ten days by the electrical reactions.

### Role of Electrical Stimulation

It is generally agreed that electrical stimulation is a useful measure in all cases of facial paralysis, but there appears to be a difference of opinion whether it is to be used from the beginning or only in a later stage. Moreover, Newman and coworkers,<sup>8</sup> express the view that the exact value of electrical stimulation in relation to treatment is still to be determined. The same clinicians who advocate waiting with active treatment during the acute stage of facial paralysis—until the ten days for possible development of the reaction of degeneration are over—feel that there is no object in employing electrical stimulation until that time. Some of our orthopedic colleagues doubt any value of electrical muscle stimulation in paralysis and strongly voice their conviction that voluntary muscle exercise is the most desirable form of activity, and that no other method can have the same physiologic value. Experimental evidence is being cited by Chor and coworkers<sup>9</sup> that electrical stimulation cannot retard atrophy and degeneration of a denervated

muscle, and that the degree of regeneration of the peripheral nerve is not influenced by physical measures.

Against such doubts stand the practical experience of numerous clinicians extending over many years and attesting the value of electrical muscle stimulation in general. Since paralyzed muscles are unable to do any active work, it seems self evident to many physicians that a method which enables the muscles to contract should be a desirable one. Tilney<sup>10</sup> says: "Electrical stimulation causes movements similar to the normal ones and helps to preserve at least part of the functional properties of the muscle until normal impulses return." Souttar and Twining<sup>11</sup> state: "Were we limited in the treatment of peripheral nerve injuries to one method of treatment and had nothing but the muscle to consider we should ourselves prefer electrical stimulation to all other methods." Neither of these two authors is a physical therapist.

Among newer experimental evidence as to the value of electric stimulation is the work of Langley<sup>12</sup> and Hartman and Blatz.<sup>13</sup> In a more recent study Fischer<sup>14</sup> concludes: "Experiments with electrical treatment starting at various times after denervation demonstrated that the best results are obtained with a treatment starting immediately after denervation, and that the strength and the duration of the electrical currents must be adapted to the changing excitability of the atrophying muscle. It is postulated that the electrical treatment causes mainly a training effect in the denervated muscle, similar to that in normal muscle, which only increases the size of the fibers and their metabolic capacity." In surveying the work done so far the same author states: "Preference of weak and ineffective stimulation for therapeutic use is astonishing." In order that the findings of any experimental work be acceptable for clinical interpretation it should be carried on in a manner comparable to clinical application. It seems significant that in the negative experiments of Chor only ten contractions were administered daily to the gastrocnemius-soleus muscle, while in Fischer's work the same muscle was stimulated daily for 12 to 20 minutes.

On the basis of extended clinical use and the above mentioned experimental evidence it would appear that the case still rests on the judicious employment of electric stimulation in paralysis, alongside with heat, suitable support, and the earliest possible use of voluntary exercise.

#### Methods of Electric Stimulation

As long as we accept that electrical stimulation is useful in maintaining physiologic activity in weak and paralyzed muscles and that when correctly applied it cannot do harm, there is every reason why carefully graded stimulation should be employed in all cases from the beginning. Besides its physiologic effect it helps to bolster the patient's morale, which is usually badly impaired by the dramatic appearance of a "crooked face." Clinicians using the static wave current from the beginning report great satisfaction from the combined use of decongestion and electrical stimulation. I recall no patient with Bell's palsy during the past fifteen years in whom such treatment immediately applied would not keep the case in the class designated as mild, which usually cleared up within four weeks. The static wave exerts stimulation of muscles through the direct action on the nerve trunk. Similar stimulation of the nerve can be achieved by the surging faradic or interrupted galvanic current as long as it is carried out in an intelligent manner, avoiding overtiring. It is still a moot question whether such early treatment through the nerve may exert an influence upon its excitatory mechanism or acts only upon the contractive mechanism of the muscle.

In early cases of traumatic and toxic facial paralysis careful stimulation through the nerve also appears to be indicated. It need not consist of more than a few contractions at first. In all cases in which irritability through the nerve is maintained, electric treatment may be continued only until it can be replaced by voluntary exercise.

A different method of stimulation is indicated in cases of Bell's palsy, which are referred at a late stage by their over-cautious or not so well informed physicians, and in which pressure on the nerve had brought on degeneration. Degenerative changes are also present in all moderately severe and more serious forms of traumatic and toxic paralysis. In all these cases there is no response to any current applied through the nerve. Direct motor point stimulation must be produced by the most effective or most easily tolerated form of low frequency current. This can be either the interrupted galvanic, slow (galvanic) sinusoidal, or a modulated alternating current. It is doubtful whether return of function is ever speeded up by such treatment; on the other hand it is likely that it counteracts atrophy of the smaller muscles, just as atrophy of the small intrinsic muscles of the hand in nerve injuries may be combated by suitable electric stimulation. This view is corroborated by Fischer's findings that in properly treated cases of paralysis a marked arrest of atrophy occurs as measured by the relative increase of weight and of excitability of the muscle.

Something must be said about late contractures which appear in the smaller face muscles in a number of severe cases, especially untreated ones. There is no evidence that such contractures have any relation to excessive faradic stimulation, as has been claimed. But when they are present it would seem better to pursue only sedative and relaxing physical measures, such as diathermy, gentle stroking and mirror exercises.

#### Role of Other Physical Measures

Voluntary impulse whenever possible is undoubtedly the most important means to restore muscle tone. Re-educational exercises are indicated therefore from the earliest possible moment, and electrical stimulation can be abandoned as soon as voluntary exercise can be carried out by all affected muscles.

Physiologic rest of the paralyzed muscles and prevention of their over-stretching by the normal ones is as important a measure as splinting in paralysis of extremities. The sagging of the paralyzed side can be prevented by several well tried means: adhesive strapping, an elastic strap or a padded fish-hook inserted in the corner of the mouth and held around the ear.

Massage is of comparatively little value in facial paralysis, but when gently applied it comforts the patient and helps in maintaining muscle tone.

#### Prognosis and Results

The role of electrodiagnosis in reference to prognosis needs no special evaluation. Together with the clinical findings, it enables classification into light, moderate, and severe cases. Light ones may take from two to six weeks for full recovery, moderate cases up to three months, and severe ones up to one year. As repeatedly emphasized, there appears to be no valid reason to withhold treatment in the average type of Bell's palsy until the question of nerve degeneration is settled.

Treatment by physical measures should be continued as long as there is room for improvement. This may mean a period anywhere from four weeks to a year. The electrical reactions serve as an important guide for continuing or discontinuing treatment, especially in traumatic cases. Regarding ear cases, Nühsmann<sup>15</sup> states that if facial paralysis lasted two months or



longer and there is complete lack of electrical response of the nerve and of all muscles, the possibility of restitution is highly doubtful. Most otologists are inclined to continue conservative treatment even in case of known severance of the facial nerve, as long as electrical reactions are present. The facial nerve has a very marked power of regeneration. In cases at a standstill or hopeless, well tried methods of plastic repair are available<sup>16, 17</sup>

Despite the number of comprehensive papers reporting on several hundred cases, dependable statistical data on end results with physical therapy in the different forms of facial paralysis seem to be lacking. The available statistics concern themselves chiefly with the age and sex of patients, the question of right and left side and the percentage of cases due to exposure. It would seem highly desirable that a controlled series of cases, treated and untreated, be observed in a large clinic, so that the desirability of early treatment and the possible advantages of different forms of treatment be statistically established beyond doubt.

### Summary

1. Physical measures are the main standby of conservative treatment of facial paralysis.
2. In the rheumatic or refrigeration type of facial paralysis the immediate employment of decongestive measures, thermal, electrochemical or mechanical, is indicated.
3. The former dictum that no treatment and especially no electricity should be applied in the early stage of facial paralysis is erroneous. Careful electrical stimulation may be applied in most cases of facial paralysis from the beginning. It does not speed up return of function, but preserves the functional properties of the muscles and may counteract atrophy and contracture.
4. Voluntary exercise is most desirable for restoring muscle tone and should be used as early as possible. Support of sagging facial muscles is of great importance. Massage has only a limited value in the management of facial paralysis.

2 East 88th Street.

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### Discussion

**Dr. M. K. Newman** (Detroit): Our very able essayist has presented a lucid and clear cut discussion of the problem of treatment in relation to facial paralysis. In a consideration of the refrigerator type of facial paralysis, we find that a considerable number of our professional brethren are or have become therapeutic nihilists either because of ignorance of methods of management, lack of proper physical equipment or sheer laziness, because of other interests in the problem at hand. It is a well known fact that the average practitioner tells the patient with a Bell's palsy to go home and not worry about the crooked face because "it'll clear up in a few weeks." Or the neurologist and otologist tell the patient to come back in a few weeks after giving them some instruction as to application of heat and the taking of medicine. This course of action results in severe psychic trauma in sensitive patients and a feeling of hopelessness in others. Pathologically, at this time, edema and swelling about the nerve trunk are going on within the fallopian canal, and the inception of possible irreparable nerve damage is being established.

Our essayist makes a very sensible and practical statement in his story of the fire brigade when he says that "waiting for the degenerative nerve changes would remind one of a fire brigade carefully watching a fire which just begins to smolder and standing ready to attack it as the flames have fully enveloped the house, but not a minute earlier." By applying decongestive measures during the first ten days of the involvement a material aid in lessened nerve damage is afforded. Thermal measures such as radiant heat or high frequency heat or even vasodilatation by means of parasympathetic stimulation (electrophoresis with acetylcholine hydrochloride) provide a means of increasing the circulation in order to facilitate the absorption of the inflammatory exudate.

The use of the static wave current by the essayist and the use of galvanism as advised by Granger occupy a definite place in decongestive management. The best method to use is the one in which the operator has had the most satisfactory results. Then the great question arises, as far as the remainder of management of facial paralysis is concerned, as to the use of electrical stimulation, especially the time and strength of current. Last year we presented a paper at the Congress

which concerned itself with the physical therapeutic management of thirty cases of facial paralysis. An attempt was made to evaluate clinically the results in half the cases treated with heat, massage and voluntary exercise, and the other half in addition treated with electrical stimulation. We noted generally that the rate of recovery was about the same in both groups. In the group which received no electrical stimulation, the patients complained of more discomfort and tightness of the facial muscles, and evinced a psychic reaction of trepidation as to future recovery. In those who received electrical stimulation, the attitude was that of hopefulness, cooperation was good and a greater interest was taken in the outlined home therapeutic procedures. The inference to be drawn from these observations is that electrical stimulation is of definite value in the treatment of facial paralysis. McCaskey recently stated "it seems the greatest value we obtain from this sort of procedure is that we may by such means keep our patients under observation a much greater length of time, and this enables one to make a more comprehensive study of the case. This, in view of the fact that a great many cases eventually clear up without other treatment, is worthwhile, as these patients are prone to become quickly discouraged and are usually the prey of various cults and unethical practitioners."

However, from an experimental standpoint, two schools of thought exist. Chor and his coworkers at Northwestern University, have made exhaustive histologic examinations of nerve and muscle tissues in reference to electrical stimulation.

They have been unable to note any beneficial effect upon muscle and nerve regeneration when galvanic and faradic currents are used for stimulation. They find massage and exercise of far greater value. Conversely, observations by Fischer at the Virginia Medical College, demonstrate that the use of faradic and galvanic stimulation in denervated skeletal muscle has a beneficial effect upon excitability and slows the lengthening of the chronaxia of the injured nerve-muscle preparation. He further demonstrated that weight loss is retarded or prevented and oxygen consumption is increased in an atrophying muscle. He finds no direct evidence that a treated muscle after re-innervation will regain normal strength faster than an untreated muscle. He did find that best results are obtained with

treatment starting immediately after denervation, and the strength of current to be used depended upon the varying excitability of the muscular structure. We must conclude, therefore, that experimental evidence makes a case for and against electrical stimulation. The only sensible procedure is to treat any early case of facial paralysis with all the physical and medical procedures at one's command. Electrical stimulation may be used early in the disease, even before the reaction of degeneration has been determined. The amount of stimulation depends upon the experience and common sense of the physician.

**Dr. W. H. Schmidt** (Philadelphia): Dr. Kovács has covered the subject of facial paralysis pretty thoroughly and there is not much we can add. Of course, the medical profession is bound by tradition and certain views, and precepts are handed down to us that we follow through, regardless of anything, and this, to a great extent is possibly the reason for the use of electric stimulation in the treatment of facial paralysis. I know that even though we have used electrotherapy for paretic muscles and have not seen any bad effects from it in the cases we have treated, we still feel inclined to hesitate because of the teaching that has been drilled into us that we shouldn't stimulate tissues in the early stages of paralysis.

From a rational and practical point of view, one could use physical therapy to the full extent in the beginning of facial paralysis. For instance, there cannot be any objection to the use of heat, infra-red and short wave diathermy on the very first day, for it has been my experience that the earlier one treats these types of patients the better will be the results. If they present themselves for treatment after a delay of two or three weeks or more, the chances of getting them well are lessened, and certainly it will take much longer time.

Another measure that has been applied to very good advantage, is the static current. Besides the static wave, we frequently use the static brush discharge or the blue pencil, and that is particularly valuable in cases that have pain following the development of facial paralysis. That is supposed to be a decongesting measure. I have used the static wave current in a number of these cases and have seen beneficial results. I haven't seen any that have been made worse in any sense of the word.

We must also realize that if there is marked paralysis and much sagging of the muscles, these muscles ought to be supported. If they are allowed to sag, they stretch, and the more they stretch, the more difficult it is to get a complete restoration of normal function.

In using electrical stimulation, we should always watch for the development of fatigue. As a muscle begins to tire one notices that stimulation produces a sluggish reaction which eventually disappears to even the strongest electric impulse. There are times, therefore, when only a half a dozen contractions are all one should give, and as the case progresses one may gradually increase the number of contractions depending on the

quality of muscular reaction.

The other important thing Dr. Kovács has stressed is voluntary exercise. Every one of these patients should be taught to exercise his individual facial muscles, particularly before a mirror where he can see what he is doing. Such reeducation efforts can be carried on at home. The patient should be left with no uncertain feeling of the very important role of his exercises.

Another matter the essayist stressed which I think is equally important, is that one cannot control the period of invalidism and must often continue over a long period. As long as there is any improvement showing, treatment must be continued until the patient has recovered as much as possible.

Patients who have had a mastoid operation and the nerves have been cut, present a different problem and have to be treated in a different way. Many of them do not respond for a long time, if at all. Some of them have to have the nerve sutured, and after that do show some improvement. I saw one case of very marked paralysis of the entire side of the face that had a plastic operation done. It was done by a German physician who had been forced to flee to our country. It was the cleverest work I ever saw. You couldn't detect that that face had been paralyzed, a feat achieved by the transposition of muscle fibers. So it is possible to correct these defects by plastic operations when conservative treatment produces no results.

**Dr. Albert T. Steegman** (Cleveland): Before treatment is started in a case of peripheral facial palsy, the patient should have a complete neurologic examination to determine if possible its cause. Most cases prove to be of the monosymptomatic benign variety, a fact which may contribute to failure of recognition of a more serious neurologic disease because of incomplete examination of the patient. As to the etiologic factor of the cryptogenic type of Bell's palsy, there is good reason why we should hesitate to accept the theory that it is due to chilling or refrigeration. This affection is just as common in the summer as in the winter months, and most of the patients I have seen have given no history of chilling. That chilling may be a provocative factor in some cases, no one can deny. Some cases are associated with infective neuronitis involving other cranial or spinal nerves or are caused by herpetic geniculate ganglionitis. The ear should be carefully examined in every case. As in sciatica and other types of peripheral neuropathy, the pathology of Bell's palsy is based largely upon speculation since there is little opportunity for gross or microscopic examination of the nerve in a benign disorder. There is no justification for assuming that the morbid process is not associated with parenchymatous degeneration as in the "pressure" and "tonic" types of peripheral neuropathy. In all such cases the nerve initially exhibits hyperemia and edema. These points have been mentioned with no intention of denying that early and active treatment as outlined by Dr. Kovács should not be given. If decongestion can reduce the swelling of a peripheral nerve that courses through

a narrow bony canal, it makes little difference whether the swelling is produced by early parenchymatous degeneration, by an exudate in the nerve sheath, by herpetic infection of the geniculate ganglion, or, as Panneton has maintained, by some arterial lesion or circulatory disturbance of the "vasa nervorum" in the region of the geniculate ganglion. The essayist has correctly pointed out that electrical stimulation is not the cause of the contractures that tend to develop in the severe cases. It is equally important to state that electrical treatment will not prevent their development.

There is little irrefutable evidence that early treatment will prevent a severe involvement of the nerve, since the degree of severity in untreated cases varies all the way from mild to severe, and early treatment does not seem to prevent some cases from going on to severe involvement. Although electrical muscle stimulation is useful in the treatment, the employment of measures to prevent overstretching of the weak muscles, controlled massage in the direction of action of the weak muscles, and mirror exercises are equally important. The patient should be warned against self-treatment without instruction, especially vigorously rubbing the face. This may nullify the beneficial effect of the treatment being administered by the physician.

**Dr. J. E. G. Waddington** (Detroit): I wish to call attention to several stimulative measures, particularly to the popular application of galvanism. It is true that negative galvanism is stimulative to muscle tissue; nevertheless, d'Arsonval years ago evolved the principle, now generally recognized, that more muscular or trophic stimulation is derivable from an interrupted galvanic or direct current than an uninterrupted.

When treating paralyzed or weakened musculature it is not necessary or beneficial always to evoke perceptible contractions; invariably I commence with the current (interrupted direct current or the direct current pulsatory sinusoidal) diminished in intensity to about one-third or one-half of that which would produce a barely perceptible contraction of the corresponding normal muscle or muscles.

It is essentially important, therapeutically, to guard against undue stimulation (irritation) or inciting a contractile response not in accord with the degree of muscular impairment or weakness. Undue exercise or contractile reaction only adds insult to injury by accentuation of an already existent de-

teriorative process. It is not necessary to visualize or perceive a contraction in order to appreciate stimulative effects from a current administered below the threshold of perceptible motor reaction.

Another important agency mentioned was ionization. Years ago I spent some time at the Salpêtrière, with Bourguignon, who was using calcium chloride applied at the positive pole of a direct current for the treatment of certain cerebral traumatism. Bourguignon claimed to have obtained marvelous results from such ionization in overcoming paralytic reactions consequent to injuries sustained during the War. Shortly thereafter, I met Professor Leduc who as yet know introduced the theory and scientifically developed the application of ionization. I could not understand why Bourguignon applied calcium chloride on the positive pole in an endeavor to soften or absorb cicatricial tissue, the positive pole being vasoconstrictive in effect. Leduc explained: "It is not the ions which are applied externally, but the ions which are able to arrive at a certain designated point within the tissues, which effect desired results. It is immaterial whether calcium chloride or any other ionizable medicament be applied at the positive pole, so far as affecting a cerebral or any other traumatism."

"The direct current itself will transport certain ions contained within the body tissues, the more rapid hydrogen and hydroxyl ions; and upon such transportation depend the therapeutic results."

Negative galvanism is stimulative and absorptive and only infrequently requires any extraneous ions introduced in order to achieve desired vasodilative reaction.

**Dr. Richard Kovács** (closing): It is pleasing to note all the discussers were so kind to prepare their discussion without comparing notes and agreed on all essential points, and it seems we are the majority, because it came out with such force. Maybe any one who has a different opinion may not have felt the desire or urge to take the platform.

There is nothing dramatic in the treatment of facial paralysis. It is one of the things most of us have done day by day for many years. The dramatic thing is when it occurs and we want to help that person, and as I said, it is a mental stress, and the earlier we deal with it and the more rational or physiologic are the measures, the more we can best serve our purpose to relieve pain and suffering and restore function.



# EFFECT OF THE GALVANIC CURRENT ON PARALYZED MUSCLE

## An Experimental Study on the Dog

C. O. MOLANDER, M.D., and F. S. STEINITZ, M.D.

With the Assistance of

R. ASHER

Physical Therapy Department, Michael Reese Hospital

CHICAGO

Modern medicine is increasingly employing methods of experimental research and discarding those which rest on empirical findings for which no scientific basis as yet exists. Obviously, such an approach, by disclosing the merit of a given procedure, either eliminates the unnecessary expenditure of energy on unsatisfactory forms of therapy and points out the need for some entirely different therapeutics, or it establishes its real worth.

Unfortunately the value of treating muscle disorders with electrical currents has never been established nor is the apparent clinical improvement, seen so often by the neurologist and physical therapist, in any way understood. Wexberg<sup>1</sup> holds that contractions of paralyzed muscles produced by electrical stimulation have far more value than ordinary gymnastics, since muscles are caused to contract which otherwise would not react at all. Similarly, Pollock and Davis<sup>2</sup> state that stimulation by an electric current of sufficient strength to produce a contraction of the muscle will conserve its bulk and nutrition and keep the muscle fibers functionally adequate for voluntary movement when regeneration has sufficiently progressed. Whether electrical stimulation truly maintains the bulk and nourishment of muscle is a problem which has been subjected to almost no controlled clinical investigation. Animal experimentation could conceivably not only shed light on this question, but, should it prove that controlled muscular activity is physiologically beneficial, also disclose the mechanisms involved. Up to the present time research on this problem is not only scant but contradictory.

The earliest studies on electrotherapy were made with frogs and rabbits by Reid<sup>3</sup> and Brown-Sequard,<sup>4</sup> who reported that daily electrical stimulation prevented the atrophy of muscles paralyzed by nerve section. Langley and Anderson<sup>5</sup> and later Langley,<sup>6</sup> using a comparable technic on rabbits, were unable to confirm these results. On the basis of the latter's work, and due to the large variations of muscle atrophy found in his own experiments, Roberts<sup>7</sup> came to the conclusion that weight gives a very poor index of the value of a treatment of paralyzed muscles. (Interestingly, Hartman and co-workers,<sup>8</sup> using massage, found that weight was not a consistent criterion of function.) Roberts further concluded that "internal movement of the muscle itself maintains a condition of mobility in the sarcoplasm and prevents fibrosis during the regeneration of the sarcostyle." In accord with these findings, Chor and Beard<sup>9</sup> have demonstrated, in monkeys, that muscle atrophy following nerve section progresses up to a period of at least six weeks despite treatment with electrical currents. Hines and Knowlton,<sup>10</sup> after experiments on five rats, also report that electrical stimulation does not affect the rate of atrophy of muscles; they stimulated the muscles for a period of 120 hours with the animals under luminal anesthesia. At the other



extreme, Chor and his coworkers<sup>11</sup> found in two monkeys, treated after nerve sectioning, more atrophy of the treated than of the untreated muscles. In contrast, Fischer,<sup>12</sup> experimenting on adult rats, obtained good results by stimulating immediately after denervation, with the faradic current and later with the galvanic current. Loss of weight of the muscles was minimized or markedly reduced. However, the currents used were so strong that the animals had to be anesthetized during stimulation.

Other investigators have approached the study of this phase of electrotherapy from different standpoints. Thus Stookey<sup>13</sup> believes that the circulation is improved by electrical stimulation and therefore nutrition maintained and waste products are better removed. Wolfson<sup>14</sup> could not prove, by cannulation, that the blood flow in a normal muscle was increased by an electric current of clinical strength, but noticed a change on application of a much stronger current. He suggests that contraction itself produced the changes.

Cook and Gerard<sup>15</sup> by stimulating the peripheral end of a severed nerve, have shown that a more rapid loss of irritability and conductivity is produced than in the unoperated nerves, and that the nerve degenerates more rapidly. Tinel,<sup>16</sup> on the other hand, thinks that electrical stimulation hastens regeneration of the nerve thus maintaining the nutrition of cicatricial fibrous tissue.

In an attempt to test further the therapeutic value of electrical stimulation of paralyzed muscles, we have undertaken a series of experiments on dogs. The gastrocnemius muscles were paralyzed by sectioning the sciatic nerves. Electrical stimulation was produced with a galvanic current, because, while normal muscles do react to a faradic current, denervated skeletal muscles require stimuli of much lower frequency. The W. W. Brown Galvometer (110 volts, 50 watts) was used in producing the stimulation; its reliability was always tested before application.

### Procedure

Eleven dogs were studied. With the animals under sodium pentobarbital (nembutal) anesthesia injected intravenously in dosages of 25 mg. per kilo body weight, the right and left sciatic nerves were exposed in the region between the greater trochanter of the femur and the ischial tuberosity. The nerves were then severed by a sharp razor like blade and immediately sutured with quadruple zero (0000) silk (fig. 1). The following postoperative treatment was given: 300 cc. of a 5 per cent sterile glucose-saline solution was injected subcutaneously, 0.5–1 Gm. of sulfapyridine administered orally. Heat was applied to the body by an electric radiator.

Immediately after the operation both hind limbs were put into light-weight Castex casts (fig. 2). The legs were thus kept immobile in a neutral position (semi-flexion) throughout the six weeks of each experiment, except for the short periods of daily treatment. The dogs were put in small cages, to limit their exercise to a minimum.

On the day following the operation the gastrocnemius muscles of both legs were tested for ability to contract to the faradic and the galvanic current; this procedure was repeated every two weeks and just before sacrificing the animals. The treatment consisted of stimulating one leg by the galvanic current using a bipolar technic, the other leg serving as a control. The leg so treated was alternated in successive dogs.

Before treatment, the skin covering the paralyzed muscle was shaved and moistened with a warmed hypertonic saline solution. After the electrodes of the galvometer were similarly moistened, the larger was applied

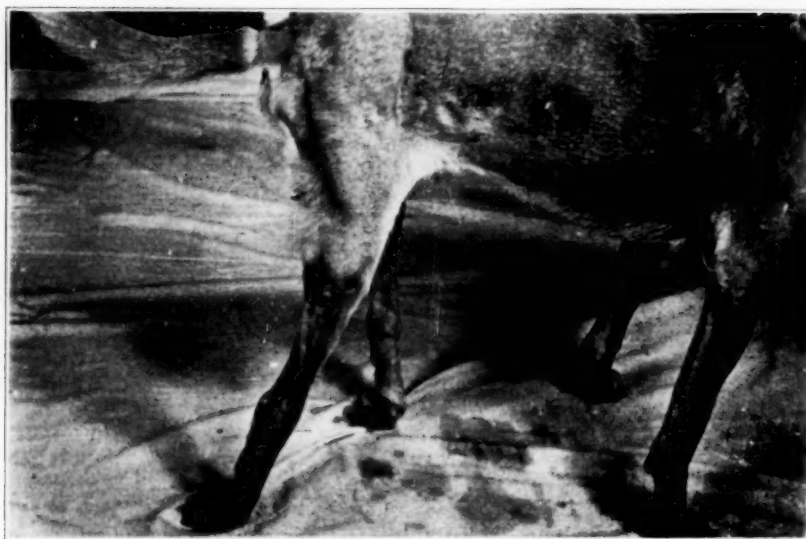


Fig. 1. — Position of dog's hind legs after sectioning of both sciatic nerves.

to the upper part of the belly of the muscle and the smaller to the lower part of the muscle close to the Achilles tendon. Contact was then made and, save in the instance mentioned below, the current was adjusted to just produce visible contractions of the muscle (fig. 3). In order not to fatigue the muscle by excessive stimulation, treatment was given twice daily, each consisting of five contractions.

This procedure was carried out in one animal for three weeks following the operation and in each of the remaining ten dogs for a period of six weeks. Two of these received infra-red radiation over the paralyzed muscle region for the twenty minutes preceding treatment, in order to decrease skin resistance, both legs being radiated but only one getting electrical stimulation. Finally, two other dogs were stimulated on both legs, one being subjected to sufficient current to produce a marked contraction while the

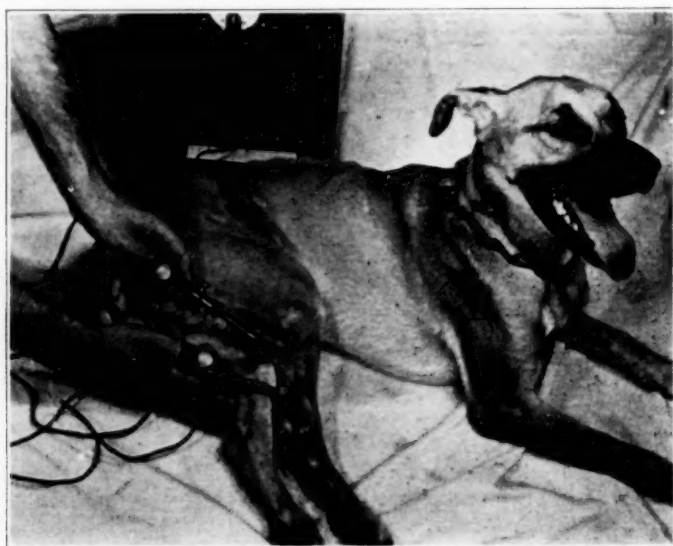


Fig. 2. — Mode of stimulation with the W. W. Brown Galvanometer.

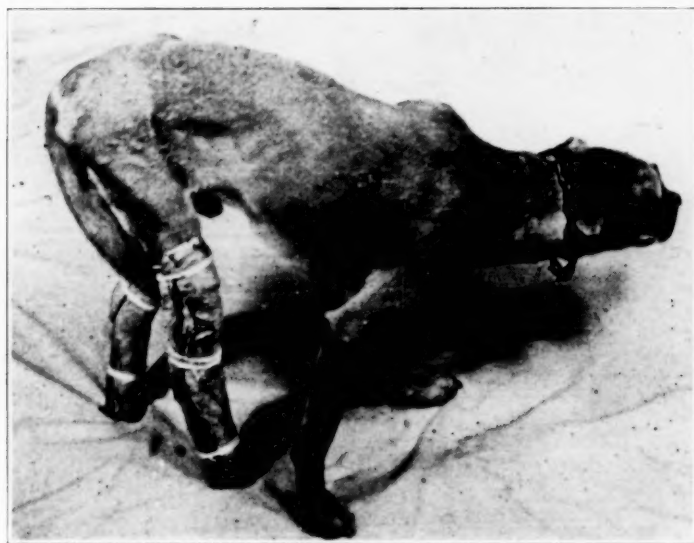


Fig. 3. — Dog with Castex casts. Note that casts can be opened on side.

other received a current so strong as to produce an even more marked contraction. In both of these animals this reaction caused discomfort. Except for those with the strong current, these methods are similar to those used on humans.

At the end of the treatment period each dog was sacrificed with an overdose of nembutal. The original incisions were opened to expose the sutured sciatic nerves. This portion of both nerves as well as both gastrocnemius muscles of each dog were carefully excised. The gross weight of each muscle was taken and then its volume determined by immersion in a graduate cylinder filled with a known amount of formalin. The aldehyde was used in order to avoid any histologic changes of the muscle. The muscles and nerve sections were then preserved in a formalin solution to be later examined microscopically. One brachial muscle of each dog was also removed and treated in an identical manner; this muscle, being a normal one, served for comparison in the microscopic examination. The right and left gastrocnemius muscles of eleven normal dogs were likewise excised and their weights noted.

### Results

In no instance did faradic current produce contractions of the paralyzed muscles. In general, as seen in table 1, both treated and untreated limbs required a greater amount of stimulation at the end of two weeks to produce the same strength of contraction than at the beginning of the experimental period. No definite change in responsiveness was noted with continued treatment.

In eleven normal dogs (table 2) an average difference of 1.34 Gm. between the weight of the right and of the left gastrocnemii was found. In seven of the eleven pairs, the left muscle was the heavier. At no time were both muscles of the same weight. The average difference between the weight of the treated and untreated gastrocnemius muscles of the nine dogs receiving the mild electrical treatment was 1.2 Gm.—a difference well within the range found in the normal control group and quite similar in distribution in that the left muscles, whether treated or not, were more often (five instances out of the eight in which a difference occurred) the heavier of

TABLE 1. — Studies on Eleven Dogs for Effects of Electrical Stimulation and Heat Directed to Gastrocnemius Muscle.

No. of Dog	Treated of Gastrocnemius Muscle	Untreated Gastrocnemius Muscle						Treated Gastrocnemius Muscle					
		0 Weeks	2 Weeks	4 Weeks	6 Weeks	Volume cc.	Specific Gravity	0 Weeks	2 Weeks	4 Weeks	6 Weeks	Volume cc.	Specific Gravity
		Milliamperes of Galvanic Current Required to Produce a Contraction											
1	right	4.0	3.5	3.5	5.5	18.0	1.06	4.0	3.5	1.5	3.0	15.0	1.1
2	left	7.5	4.0	4.0	3.0	10.0	1.1	7.5	4.0	4.0	2.0	8.0	1.1
3	right	5.0	7.0	6.0	9.0	18.0	1.1	5.0	7.0	6.0	9.0	19.0	1.1
4	left	8.5	19.0	14.0	dead	13.0	1.1	8.5	14.0	dead	15.0	14.9	1.0
5	left	10.0	15.0	14.0	13.0	4.0	2.3	10.0	15.0	14.0	11.0	4.0	2.2
6	right	13.0	16.0	15.0	17.0	20.0	1.1	13.0	16.0	14.0	19.0	20.0	1.0
7	left	10.0	19.0	25.0	26.0	28.0	1.1	10.0	18.0	20.0	19.0	25.0	1.0
8*	right	12.0	14.0	17.0	19.0	5.0	1.3	12.0	14.0	20.0	21.0	5.0	1.5
9*	left	14.0	23.0	20.0	23.0	10.5	1.2	14.0	23.0	20.0	22.0	10.5	1.2
10	right†	8.0	18.0	18.0	14.0	7.2	2.3	8.0	18.0	20.0	22.0	10.5	1.2
	left	8.0	14.0	18.0	22.0	8.0	2.2	8.0	14.0	20.0	22.0	10.5	1.2
11	left†	8.0	12.0	13.0	11.0	5.0	1.4	8.0	12.0	20.0	22.0	10.5	1.2
	right	8.0	20.0	15.0	15.0	5.0	1.4	8.0	20.0	20.0	22.0	10.5	1.2

\* Received infra-red radiation before each treatment.  
† Muscles excessively stimulated.

\* Received infra-red radiation before each treatment.

† Muscles excessively stimulated.

the two. In four animals the treated muscle was heavier, in four the untreated, and in one both muscles were of the same weight. No correlation could be found between the strength of the current used and the weight of the treated limb relative to the untreated. The average difference in fluid displacement by the muscles of these animals was 1.2 cc. In four cases both muscles had the same volume.

At the end of six weeks a difference in the reactivity to the galvanic current appeared in the two dogs receiving stimulation on both legs. The excessively stimulated gastrocnemius muscle in one dog required 14 ma. to cause a contraction, while only 11 ma. were required in the other. The muscles which were not stimulated excessively responded to 22 ma. in the first dog as compared to 15 ma. in the other dog. One of these animals showed no difference in volume between the two muscles, while the other showed a difference of 0.8 cc. the gastrocnemius muscle not excessively stimulated displacing the greater amount of fluid. The weight of both muscles of the first dog was the same, while the excessively stimulated muscle of the second weighed 1 Gm. less than the other muscle.

None of the dogs favored one hind leg more than the other at any time during this experiment.

### Microscopic Examination

Histologic sections of the individual gastrocnemius muscles revealed no striking variation between the treated and untreated muscles. The sections were prepared and examined by the Pathology Department of Michael Reese Hospital.

The pathologist had no knowledge of which of the muscles had been treated. The findings were as follows: cross striations were generally clear; muscle columns were focally separated; the nuclei were increased and concentrated at the periphery and there was an apparent increase in young fibrous connective tissue with focal replacement of muscles. Most of the muscles, both treated and untreated, were shrunken. Some fatty infiltration and vacuolization were also observed. In six of the nine dogs given mild

TABLE 2. — *Weights of Normal Gastrocnemius Muscles.*

Number of Dog	Left	Right	Difference	Number of Dog	Left	Right	Difference
1	43.9 Gm.	44.3 Gm.	0.4 Gm.	7	57.2 Gm.	55.7 Gm.	1.5 Gm.
2	46.6	43.4	3.2	8	50.8	50.5	0.3
3	24.6	23.5	1.1	9	27.4	29.0	1.6
4	20.4	21.5	1.1	10	10.5	10.2	0.3
5	62.1	64.0	1.9	11	26.1	25.6	0.5
6	60.0	62.0	2.0				

therapy, the treated muscle showed somewhat less extensive changes with minimal alterations. In one dog the untreated muscle also appeared to be less than usually atrophied, while in two there was no difference between the treated and untreated muscles.

In the two animals that received infra-red radiation before electrical stimulation, both the treated and untreated muscles showed marked differences from all other sections. These sections exhibited a distinct increase in interstitial tissue, along with some cellular foci, calcium deposits and muscle giant cells. In one the untreated muscle showed more extensive atrophic changes than the treated muscle, while the muscles of the other dog showed no such atrophic changes. The histologic sections from both that had received stimulation on both limbs showed focal loss of striations and some focal swelling.

Neural serial sections confirmed the gross observation that in all cases contact was established between the distal and proximal ends of the sectioned and sutured sciatic nerves. No differences were noted between the right and left sciatic nerves of the same dog or between the sciatic nerves of all the dogs.

### Discussion

In drawing conclusions from this study, one must not lose sight of the fact that the etiology of the paralysis here is wholly different from that encountered in human poliomyelitis. Because of the impracticability of producing poliomyelitis in most experimental animals and, of course, in the human, a method such as here followed is the only approach left for investigation.

From our results it is impossible to conclude that electrical stimulation has any definite value in preventing or delaying the atrophy of canine gastrocnemius muscles paralyzed by sciatic nerve section.

Although microscopic examination of the muscle sections revealed no marked changes, the slightly lesser degree of atrophy in the treated limbs of six of the nine dogs receiving mild therapy, may be suggestive. There was no difference at all in muscles of two of the remaining dogs and in the last animal the untreated muscle showed even less atrophy than the treated muscle. Muscle changes were noted, however, in the two dogs receiving infra-red radiation before electrical stimulation. Whether these changes were of increased degenerative or of a regenerative nature is very difficult to decide. The nature of these changes might well be further investigated. The two dogs in which both gastrocnemius muscles were stimulated, in showing muscular changes, loss of striation and focal swelling regardless of the varied strength of current used, gave no indication of retarded damage to muscle tissue.

Since the sciatic nerves showed no histologic changes and good contact between the distal and proximal ends of the nerve was established, it cannot be concluded that the slightly less pronounced muscular changes in some of the treated limbs were of a neurogenic nature



While our results in revealing no evidence of significant improvement of paralyzed muscles by the galvanic and faradic currents corroborate the findings of most other investigators who have used mild stimulation, the fact remains that clinical improvement has been reported. Therefore, we would suggest that further experimental studies be carried out in monkeys who, because of their susceptibility to the poliomyelitis virus, can be subjected to paralysis equivalent to that in man.

### Summary

1. A series of experiments on dogs was undertaken to determine the therapeutic value of electrical stimulation of paralyzed skeletal muscles. The paralysis was produced by sciatic nerve section.

2. Paralyzed muscles did not respond to the faradic current in any case. The treated muscles showed no less loss of weight than the others, but in six instances out of nine there was slightly less pronounced histologic evidence of degenerative change. The untreated muscles exhibited a greater responsiveness to the galvanic current than the treated muscles, but both became steadily less sensitive to stimulation as the experiment progressed.

3. Histologic sections revealed no difference in the changes in the sciatic nerves of the treated and untreated gastrocnemius muscles.

4. These experiments lend no clear support to the hypothesis that paralyzed limbs are benefited by electrical stimulation. It still remains to be demonstrated whether such benefits can occur in paralyzed limbs in poliomyelitis.

NOTE.—We are indebted to the Castex Laboratories, Inc., Watertown, Massachusetts, for supplying some of the Castex. We are grateful to Drs. M. Corrigan and O. Saphir of the Department of Pathology for their cooperation in examining the histological sections. We are further indebted to Drs. L. N. Katz, J. S. Coulter, P. Lewin and A. Verbruggen for their advice and assistance.

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(Concluded on page 182)

## ARTIFICIAL HIBERNATION THERAPY \*

M. K. NEWMAN, M.D.

and

J. M. BERRIS, M.D.†

DETROIT

Heat and cold as therapeutic aids have a venerable place in medical history. When man discovered fire, he incidently found a new means of treating his infirmities; and much has been written since ancient times until this very day upon the therapeutic application of sustained heat. Similarly, the use of cold has a prehistoric background, and was employed in the treatment of disease throughout the Middle Ages. Its uses from that time until quite recently have been simple and uncomplicated.

Perhaps one of the earliest advocates of "cryotherapy" was Michael Savonarola,<sup>1</sup> who in 1450, claimed cures of fevers by cold baths and drenchings. Later in the seventeenth century, Sir John Floyer,<sup>1</sup> published a "History of Cold Bathing" in which he attributed the disuse of cold bathing as the cause of many diseases. Simon Andre Fissot,<sup>1</sup> one hundred years later, recommended the cold bath for nervous diseases, epilepsy and bilious fever. Benjamin Rush<sup>1</sup> in 1794 used cold water in the treatment of rheumatism, gout, yellow fever and measles. Winternitz<sup>1</sup> found cold water as efficacious in controlling an influenza epidemic as quinine.

Recently low body temperatures have been used in the treatment of tumors, particularly cancer. Fay and Smith<sup>2</sup> first applied this method for the alleviation of pain in intractable cancer. Their microscopic studies demonstrated a definite deleterious effect upon certain embryonal cells when local or general temperatures were reduced below 95 F. This work was the result of an observation on the part of Fay,<sup>3</sup> who in studying body temperatures on a neurologic dermatome plan, noticed that the extremities were of a lower temperature than that of the trunk.

Coley and Higinbotham,<sup>4</sup> Mason,<sup>5</sup> Geschickter and Copeland<sup>6</sup> noted that metastatic bone tumors of the hands and feet were quite rare, and usually of low grade malignancy. They also observed that the distribution of cancer occurred more frequently about the trunk and pelvis than it did in the extremities. Huggins and Noonan<sup>7</sup> demonstrated that red bone marrow, which has properties similar to an embryonal type of tissue, disappears from the tails of rats under ordinary environmental temperatures. When the distal portion of a rat's tail or the feet were amputated, and then implanted in the abdominal cavity of the animal, the red bone marrow persisted for a long time. Smith produced many malformations and monstrosities in lowering temperatures during the early stages of chick egg incubation.

Troedsson,<sup>8</sup> deduced that body temperatures below 95 F. were not dangerous, but compatible with life in rabbits. This was an observation made at the time when Fay found low body temperatures to be compatible with human life.

Our interest in "artificial hibernation" or "cryotherapy" resulted from research as well as clinical studies in the field of artificial fever therapy. We felt that physiologic factors which are important in maintaining body equilibrium during a fever treatment are in a sense similar to those which

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† Deceased, August 1940.

are encountered in hypothermic states. Consequently we acquainted ourselves with the technic of lowering body temperatures as outlined by Fay and Smith. This was accomplished with the kind cooperation of Dr. A. McCravey of Temple University Hospital.

### Technic

In our earlier method of inducing hypothermic states, we used a regular hospital room of 11 by 14 by 10 feet dimensions. The windows were sealed. A vestibule was constructed outside the room door to prevent cold losses. When the floor nurse or intern were required, a signal arrangement summoned them. Nurses were employed on eight hour shifts and were relieved every two hours. The temperature of the sealed room was lowered by means of a compact one and one-half ton cooling unit provided by the Nash-Kelvinator Corporation. For the continuous recording of body temperatures, an electric resistance thermometer of the Alnor type with a rectal electrode was used.

In the preparation of the patient a thorough diagnostic survey was made which included preliminary studies to establish a basis for physiologic observation during treatment. A cleansing enema was given routinely before the institution of any treatment. Anesthesia was produced by the intravenous injection of evipal or pentothal sodium; unconsciousness was manifest in a few seconds. The hands and feet were immediately bound with padded restraints. Anesthesia was maintained throughout the session by instilling rectally 5 to 6 drachms of fresh paraldehyde in physiologic saline solution, or a 3 to 4 dram dose into the stomach through a Levine tube. We preferred the former procedure due to the danger of aspiration of the stomach contents when excitement occurred at 93 F.

The body was packed from head to foot in bags containing chopped ice. These containers were used, instead of immersing the body directly in chopped ice since skin burns occurred occasionally as a result of direct contact. Usually four to eight hours were required to lower the body temperature to 90 F. At this level inertia was established which carried the body to about 88 F. During the period of induction the room was cooled to 55 F. by the air conditioning unit. The humidity is not considered an important factor since at this temperature level the air is not saturated above twenty per cent.

The first few patients received no fluid during treatment, but it soon became apparent that dehydration occurred here as in fever therapy. The routine was changed to permit the patient to receive two ounces of physiologic saline solution in ten per cent dextrose every few hours. Specimens of urine, blood and feces were obtained twice daily. Basal metabolic studies, skin temperatures and electrocardiographic observations were made once daily. In order to maintain a temperature equilibrium with the room, the patient was covered with blankets when the temperature dropped below 85 F. If it rose above 88 F. a few ice bags were added. In this manner it was possible to maintain the patient between 85 and 88 F. during the entire course. Treatment at this level was carried out from three to five days.

Induction was later modified by the construction of a large rubber blanket containing numerous longitudinal tubes. An individual cooling unit circulated Prestone through the blanket. Temperatures then in contact with the skin were identical with that obtained from the ice. Ice bags were no longer necessary. Recently Dr. L. Phillips of the Nash-Kelvinator research staff developed an ingenious "sleeping bag." Similar to a fever therapy bag, temperatures could be lowered in a like manner. With this apparatus,

it was possible to dispense with the cold room and air conditioning equipment. Richards of the Toronto General Hospital, has developed a cooling cabinet which operates on the same principle as a heated and humidified fever cabinet.

Selection of patients was governed by age, previous therapy and relative prognosis. When surgery and roentgen irradiation were no longer feasible the patient became eligible for refrigeration. Moribund patients and those in the sixth to seventh decade of life were rejected. In general the prognosis for life before treatment varied between four and eight weeks. All the morphine addicts subjected to treatment were young and healthy individuals.

### Clinical Interpretation

Contrary to common belief, patients do not remain unconscious. Most of them are able to talk with those about them. They recall both recent and remote events. Speech is slow and thick but quite understandable. Thought processes are orderly. Patients obtain from 12 to 15 hours of sleep daily while under treatment. In men the growth of beard in a 3 to 5 day interval corresponds to that of a normal 24 hour growth. Some difficulty in swallowing is present, but it is possible that this is the result of trauma incident to the insertion of the nasal catheter. Micturition occurred regularly irrespective of sex. Only one patient had a definite bowel evacuation. Vomiting occurred in several cases but only after instillation of paraldehyde. Amnesia of events during treatment was evident once consciousness was regained (table 1).

Examination of the blood was carried out daily on all patients before, during and after treatment. Invariably the total red count rose during the first two days. This is accompanied by an associated hemoglobin rise and is undoubtedly a hemoconcentration due to dehydration, which is not obviated by fluid intake. The size and shape of the red blood cell was infrequently altered. Repeated treatments were not conducted; hence, the premise of Smith that actual anemia results could not be verified. Variation in red counts of two million cells per cubic millimeter were observed.

The white blood cells were constantly increased during and immediately following treatment, reaching a level of 15,000 to 20,000 in number. These observations are similar to Smith's, who explained the phenomenon as possibly due to an accumulation of white cells in the smaller vessels through increased circulation time. The differential count was not abnormal.

In one case a total white count of 1300 was only slightly elevated during treatment. In this patient a type II blood became type III during treatment. An attack of acute hemorrhagic pancreatitis made it necessary to stop treatment. This may have been in some way responsible for the change in type.

Observations were made daily on the nonprotein nitrogen. In a few cases we studied the urea nitrogen as well as the chlorides, creatine, calcium and phosphorus and blood sugars. Five patients demonstrated rapid rises of the nonprotein and urea nitrogen during or immediately following treatment. We feel that a rapidly rising nonprotein nitrogen is a definite indication to stop treatment. Dehydration is apparently not a factor because the other blood chemistry components were not elevated. Smith does not make this observation; he finds no nitrogen retention.

No appreciable effect was evident on blood chlorides. Elevation and diminution of chlorides occurred with equal frequency. Dehydration, however, does occur, and the introduction of saline solution materially aids the

TABLE 1. — Summary of Fourteen Patients Treated by General Refrigeration.

Case	Age Sex	Diagnosis	Treat- ment	Results	Remarks
1. C. M.	38 M.	Gastric cancer. Local extension. Exploratory confirmation. Local tumor mass.	120 hrs. 85-88 F.	Symptom free for 4 months. Able to resume selling activity.	Metastasis to rectal shelf in 4 mos. Lived 5 mos. Original prognosis 2 mos.
2. R. S.	48 F.	Primary cancer left breast. Metastases to ribs, pelvis femora. Generalized bone pains. Adenoca by biopsy.	108 hrs. 85-88 F.	Died during treatment. Symptoms of cyanosis, shallow respirations and exodus.	No autopsy permitted.
3. E. W.	38 F.	Primary cancer liver. Large right upper quadrant mass. Adenoca by biopsy.	110 hrs. 85-88 F.	Died during treatment.	Autopsy showed broncho-pneumonia. Regressive changes in tumor mass.
4. M. H.	53 F.	Cancer left ovary panhysterectomy X-ray. Generalized abdominal metastases.	110 hrs. 88-90 F.	Died 48 hrs. after treatment. Mesenteric thrombosis cause of death.	Patient showed metastasis to liver and peritoneum. Also had falx cerebri.
5. R. S.	50 M.	Primary cancer of rectosigmoid, marked weight loss and anemia. Large friable mass in rectum.	120 hrs. 85-88 F.	Progress uneventful during treatment.	Autopsy showed metastatic lesions in liver; left lower lobe lobar pneumonia. Died 4 days after treatment.
6. M. D.	46 F.	Gastric cancer. Large abdominal tumor mass. 4 week prognosis. Unable to take more than 1-2 oz. fluid. Edema and general ascites.	82 hrs. 85-88 F.	Able to take 8-10 oz. fluid. No change by X-ray.	Lived 3 months after treatment. No pain or discomfort.
7. N. G.	51 F.	Cancer sigmoid. Inoperable with metastases to rectal shelf and abdomen. Pain and debility.	72 hrs. 85-88 F.	Gain in weight. No Pains. Able to eat regular diet.	Excellent results. Patient still alive.
8. C. E.	47 M.	Hodgkins disease 3 yrs. Generalized adenopathy. Pel Epstein fever. Severe anemia. Positive biopsy.	72 hrs. 83-86 F.	Type II became Type III blood. Developed severe abdominal pain during treatment.	Change in blood type. Acute pancreatic fat necrosis.
9. G. G.	49 F.	Cancer right breast. Metastases to both lungs and nodes.	72 hrs.	Developed respiratory difficulties after removal.	Supportive treatment of no avail. Elevated NPN.
10. D. G.	24 F.	Hemangioendothelioma of left shoulder with much blood oozing. Terrific pain in shoulder. 4-5 grains morphine. Secondary anemia.	24 hrs. 48 hrs.	Complete relief of pain. No further addiction. Tumor mass smaller.	Typical addiction symptoms; complete cure. Patient died 2½ months later of hemorrhage.
11. F. M.	34 M.	Morphine addiction. 6 grains i. v. daily.	30 hrs. 83 F.	Required heavy medication.	Cured for 5 months.
12. C. W.	40 M.	Morphine addiction. Morphine diluted — 10 gr. cocaine — 1-2 grs. Barbitol — 10-20 grs. Hyoscine — 1/50 gr.	72 hrs. 85-88 F.	Heavy medication.	Complete cure in 8 months.
13. S. J.	48 F.	Cancer breast.	Unable to lower temperature for 24 hrs.		
14. D. C.	30 M.	Teratoma right testicle. Metastases to right lung. Severe hip pain.	72 hrs. 85-88 F.	Complete pain relief. No change in lung X-ray.	Relief for 2 weeks then relapse.



patient. Creatinine rose with treatment and fell upon its discontinuance. Calcium and phosphorus determinations were inconclusive. Observations on blood sugar failed to show any appreciable variations. Carbon dioxide content of the blood was of no significance.

The total output of urine corresponded to within a few drams of the total fluid intake. The urine temperature was constantly one to two degrees below the rectal temperature. Its specific gravity depended upon fluid intake. No evidence of kidney damage was manifest since cells and casts were absent. Chemical analysis of urinary constituents failed to show anything unusual.

The circulation has not been adequately studied in this series. Oppenheimer<sup>9</sup> noted that the rate of circulation was nearly doubled in the peripheral vessels. Blood pressures were obtainable in only thirty per cent of our patients. Systolic pressure was invariably below eighty. Diastolic pressure was only rarely obtained. The peripheral radial pulse was palpable in an equally small percentage. Dorsalis pedis and posterior tibial pulses were seldom palpated. Venipuncture was difficult due to constriction or collapse of the veins.

Basal metabolic studies were entirely unsatisfactory. Normal or only slight reduction in rates were obtained. The cooperation of patients was poor due to their inability to hold the rubber mouthpiece. Geiger<sup>10</sup> found the metabolism to be depressed by continued low body temperature.

Skin temperatures were reduced to 18-23 C. in the extremities. Trunk temperatures corresponded closely to rectal temperatures. Acrocyanosis was generally present and corresponded to the extremely low skin temperatures.

Electrocardiographic studies revealed only a sinus bradycardia and slurring of the QRS complexes. PR, QRS, and RT times were generally prolonged. No cardiac damage occurred as evidenced by normal curves following treatment. Kossman<sup>10</sup> found abnormalities of the T-wave and frequent auricular fibrillation. No fibrillation occurred in our 14 cases (table 2).

TABLE 2. — *Electrocardiographic Studies of Six Patients Given General Hypothermy.*

<i>Electrocardiogram.</i>		
Case	Changes	Skin Temperatures
1. C. M.	Sinus bradycardia. QRS complexes slightly slurred.	Marked fall, mostly in extremities.
4. M. H.	Sinus bradycardia. QRS time prolonged.	Extremities 19-23 C.
6. M. D.	Normal. Somatic tremor.	
7. N. G.	Normal curve.	
11. F. M.	Sinus bradycardia.	
12. C. W.	Normal curve.	

### Local Refrigeration

The technic of local refrigeration is relatively simple. It requires a few feet of coiled rubber tubing or some applicator for insertion into the body cavities. This method may prove of considerable value. Elaborate apparatus is unnecessary, the required articles costing very little. The remarkable relief from pain in five or six patients obtained by this simple means indicates a possibility of utilizing it as home treatment (table 3).

TABLE 3. — *Summary of Six Patients Treated by Topical Refrigeration.*

Case	Age Sex	Diagnosis	Treatment	Results	Remarks
1. H. A.	68 M.	Cancer bladder.	Local treatment at 40-45 with bulb and unit for 3 weeks. Repeat again for 2 weeks.	Immediate relief of pain. First biopsy positive. Second biopsy after 1 month negative.	At autopsy surface of bladder fibrosed. Cancer is below mucous membrane.
2. B. P.	55 M.	Prostate. General metastases in spine and ribs. Terrific pain. Partial transverse myelitis.	Local coil at 35-40 for 3 weeks. Ice bag at home.	Relief in 3 days. Able to walk and control bladder.	Lived in comfort for 5 months using ice bags.
3. R. W.	34 F.	Primary cancer left breast. Metastases to ribs and left pleura.	Local coil at 35-40 for 2 weeks. Ice bag at home.	Slow but definite relief in 5 days. Relief persisted for 3 mos. until exodus.	Off morphine. Went through one therapeutic abortion one mo. later. Free of pain until death.
4. J. K.	65 M.	Cancer of right mandible from cancer lip.	Local coil at 40 for one week.	No relief.	Later metastases shown to be osteomyelitis.
5. H. S.	60 M.	Cancer for sigmoid with pain in pelvis.	Local bulb at 40 for 3 weeks.	Relief of pain during 3 weeks of treatment.	Died 2 months after treatment. No return of pelvic pain.
6. J. C.	35 M.	Cancer sigmoid with local extension. Colostomy.	Local treatment for 3 weeks with bulb at 40.	No symptomatic relief.	Original biopsy taken. Later biopsy showed regressive changes.

The materials consist essentially of rubber tubing, a small centrifugal pump, applicators designed to fit the affected body cavities or surfaces, and plenty of ice. A closed circuit is then constructed with the pump, rubber tubing and the applicators, the latter in contact with the concerned surfaces. Ice water circulating at temperatures of 35 to 40 F. will then produce the necessary refrigeration. The following two examples illustrate the value of topical refrigeration:

CASE 1. — B. P., age 55, had extensive metastases to the spine and ribs, with excruciating pains, incontinence and partial paralysis of the lower extremities. After three days of treatment the bladder control returned. The patient was able to move his legs and actually stand. Severe pain had disappeared. He lived in comfort for five months. Recurrences of pain were readily controlled with the application of ice bags.

CASE 2. — R. W., age 34, had early metastatic lesions in the ribs and pleura. The pain was almost unbearable. Within five days of local treatment, all pain had disappeared, and the patient lived in comfort for 4 months. She became pregnant following treatment. A therapeutic abortion was performed with no ill effects.

### Discussion

Fay and Smith having demonstrated that humans can be maintained at low bodily temperatures formerly thought incompatible with life, a new vista of research has been opened. Many years of intensive study will be required to determine the effects of cold on the body. Such studies as have been conducted indicate that no profound changes occur in the blood, blood chemistry, or urine. Definite regressive changes, however, may be evident in the pathologic examination of tissues that have been subjected to low tem-

peratures. Pain is certainly relieved. By local application of cold, it is now possible to institute home therapy for those afflicted with hopeless metastases.

It must be pointed out that a definite hazard exists in carrying out so formidable a procedure. This is especially true when the mortality statistics are considered. Fay and Smith make little or no mention of deaths during or immediately after treatment. Richards<sup>11</sup> had one fatality in connection with a morphine addict, but the cause of death was not determined. Vaughn<sup>12</sup> cites no fatalities during hibernation, but his charts indicate three deaths in six cases over a 1-7 day period. In our experience with fourteen cases, we noted two deaths during treatment. The cause of death in the first was probably a circulatory collapse. No autopsy was performed. The other patient had definite broncho-pneumonia on postmortem examination. In another patient acute pancreatitis developed at cessation of treatment with death ensuing three days later.<sup>13</sup> Postmortem examination showed extensive fat necrosis in the abdominal cavity. When pulmonary metastases are present, the patient is more likely to develop pneumonia, as occurred in one patient with a carcinoma of the breast and lung metastases. We therefore feel that only hopeless cases should be treated with general refrigeration because of the formidability of the procedure.

Most dramatic and hopeful results occur in morphine addiction. One addict with a painful shoulder cancer and two true addicts were treated with general refrigeration. Observations indicate that withdrawal takes place during hibernation as is evidenced by the severe muscle tremor and restlessness. These patients awaken with sore muscles, diarrhea, abdominal cramps and nervousness, but well satisfied not to have to continue the drug. The longest period of observation has been six months with no reversion to morphine. Certainly, extensive studies in psychiatric institutions are warranted to determine the value of hypothermic states for addiction and psychoses.

### Summary

1. Eleven patients with hopeless metastatic carcinoma and three addicts were treated with general refrigeration. Six patients with hopeless metastatic carcinoma were treated with local refrigeration.
2. Treatment time varied from eight to one hundred and twenty hours at temperatures below 88 F. Local treatments were carried out for two to three weeks at a time.
3. Determinations of basal metabolic rates, blood chemistry, hematologic studies, kidney function, and electrocardiographic studies and skin temperatures were carried out.
4. Relief of pain occurred for varying periods of time in patients subjected to general and local refrigeration. Regressive changes in tumors were noted with local refrigeration. Narcotics generally became unnecessary when relief occurred.
5. Two fatalities occurred during treatment, death being due to circulatory collapse and pneumonia. Mesenteric thrombosis and acute hemorrhagic pancreatitis seemed to result from treatment.
6. Morphine addiction appears to respond favorably to general refrigeration.

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### Discussion

**Dr. Albert Mueller** (Springfield, Ill.): I was very much interested in the paper which has just been read by Doctor Newman because our work in Springfield followed along approximately the same lines. We produced general hibernation fourteen times in our series. Two patients were treated with local cold alone. Six patients were treated with a combination of local and general cold. One patient was treated with a combination of X-ray and general cold.

Local cold was applied by means of special applicators into which we circulated refrigerated water. General hypothermy was produced by applying external cold in the form of ice packs, ice bags and cold water. Our method of narcotizing patients in preparation for the hibernation treatments varied a little from that of the authors, in that we used a good many things and eventually adopted nembutal which was given intravenously and intramuscularly. However, occasionally we found that it was necessary to supplement narcosis with insulin. Our experience with insulin, sugar, adrenalin, and cold checked with the animal experiments reported by Britton, Dworkin, Cassidy, and Suomalainen.

The physiology of local cold has been fairly well established by Bazett, in 1936, in "Principles and Practices of Physical Therapy," Vol. 1. At least, our clinical observations seemed to substantiate the material set forth in Bazett's article. We have not made any depth measurement studies because our results with the local cold treatment of accessible, malignant lesions were not encouraging. Local refrigeration was used alone, and in combination with general hypothermia for periods as long as 500 hours at temperatures of 48-50 F. While we observed cellular necrosis by repeated biopsy of the treated tumors, it is questionable whether cold applied locally has more than a superficial effect. However, we agree with the

authors that the application of cold appliances did relieve intractable pain.

Our technic varied somewhat, in that we kept our patients narcotized during the full period of treatment. The entire period of the treatment was accompanied by total amnesia. We also noted an increase in white blood cells during treatment. Our greatest increase was 37,000. We did, however, find a rather marked differential change in that there was a marked increase in neutrophils, and a decrease in small lymphocytes.

All of our patients showed abnormal urinary findings in catheterized specimens. The urine commonly contained albumin, acetone, and casts. We believe that nitrogenous wastes are piled up in the blood stream in proportion to the amount of hydration of the tissues. We found that the N. P. N. and urea N. content of the blood was not so great when 2000 cc. of fluids was introduced parenterally. Even with the fluids there was a consistent rise in nitrogenous wastes in the blood, both N. P. N. and urea nitrogen.

Basal metabolism studies were very unsatisfactory in our work. We recorded basal values of minus 30 and positive values of plus 6 during the height of the hypothermy. Our observations were made by means of an anesthetic mask. We had one death under treatment. Autopsy findings revealed general carcinomatosis with invasion of all the vital organs including the brain. One of our patients developed a chest condition from which she recovered after a stormy convalescence.

We are not in agreement with the authors regarding the efficacy of general hibernation in morphine addiction. One such patient came under our care, and received two sessions of hypothermia. On leaving the hospital she continued to use morphine to the extent of 2 grains per day until her death.

**Dr. Madge C. L. McGuinness** (New York): For cryotherapy at Lenox Hill Hospital we followed the original technic of Fay and Smith. We had a committee consisting of two surgeons, an internist, a pathologist, a neurologist, a physical therapist and the secretary of the medical board available as consultants.

Twenty-eight patients had 2900 hours of refrigeration under 90 F., in 67 sessions. Two patients had 79.6 F. for 2 hours. All of these had had everything possible done previously, and were treated here for intractable pain. Of these 22 had carcinoma, 1 sarcoma, 1 melanoma, 2 leukemia, 1 was a morphine addict and one was a schizophrenic. The findings of the various examiners were published in the Bulletin of the Academy of Medicine and discussed at the Eastern Session of the Congress, in April, 1940.

The temperature readings are particularly interesting and were rather difficult to obtain as the patients seemed always having something done and to be active. They received hourly feedings, various sedative drugs, the ice bags were being put on or taken off, the stomach was washed out twice daily, they were catheterized every 12 hours and the blood pressure was taken frequently. Most patients moved, shivered, tried to turn, attempted to remove the restraining hand and foot bands and were in constant tonus. Especially the vaseline gauze over the eyes was a source of worry. As they have coma vigil, ulceration of the lens was prevented by instilling castor oil in the eyes and by applying the vaseline gauze outside.

Local skin temperatures varied from 13 to 23 degrees below those taken at room or ward temperature. Urine falling on the thermometer was 1 or 2 degrees below the rectal temperature. Bodily temperature rises at first, during induction, 1 to 1½ degree. After the treatment, it again rises to 100-101.5 and this may last for two or three days, and as the patient has a tendency to throw off the clothes because of this, he should be protected against catching cold.

The pulse never went below 50 whatever the temperature. The blood pressure at first rose and later fell. Peripheral vasoconstriction was marked making venipuncture impossible. Oscillometric readings were reduced or absent showing a high degree of tonus. The shivering was general, especially at 97 to 95 F. It has been said that shivering ceases at 95 F., however some continued to shiver right down to 80 F. Remarkable to relate, there was no Raynaud's syndrome.

Sedatives were not required after the second or third day in the addict which offers a suggestion for the withdrawal treatment in other cases. Paraldehyde was early discontinued because of gastric distress.

The average patient is rather hazy for several days after the treatment, has no recollection of what has happened but volunteers the information that his hands and feet tingle and this may last a week. He

also states that his pain has gone and this too may last a week or more. However, eventually, the pain returns, perhaps not so severely, perhaps not in the same place, but pain was complained of one to eight weeks after a course.

Of the 28 patients, 19 died,—one of shock in the cryotherapy room with a rectal temperature of 97.5 F. One, the schizophrenic, on the ward, eight hours later, of dilatation of the stomach and aspiration pneumonia. One died seven days later of pneumonia and 16 lived from 5 weeks to four months, while several were still alive in September, 1940. Now in February, 1941, one year since the work was begun, all have died.

Of the six cases treated locally for relief of intractable pain, the pain was kept under control as long as the cold was applied but returned when the cold was removed. One patient at first had relief but unfortunately the lesion opened into the lungs and this proved fatal. From these few cases we can make no deductions. Time will tell. Dr. Newman seems to have had better luck and to manage his work better, a least, up to this time.

**Dr. L. B. King** (Hot Springs National Park, Arkansas): I would like to ask a question as to how they account for the increase in the circulation time of the blood under cryotherapy. How do they explain it physiologically?

**Dr. Louis B. Newman** (Chicago): Although cold therapy may date back to the Middle Ages, scientific therapy is relatively new. By scientific cold therapy, I mean therapy as practiced by our essayist and a limited few throughout the country. Their's has been scientific investigation worth emulating and worthy of everyone's attention. I was very glad to have heard the paper and the discussions on the subject.

Now, let's not take too hopeless an attitude insofar as the results of cryotherapy in the treatment of carcinoma are concerned. Let us analyze the type of cases that have been treated. These were the very moribund and hopeless types. Surgery, X-ray, radium had been tried but the patients were incurable. As a last resort, cryotherapy was tried. We cannot and must not expect too much. We are not going to cure these patients at least with our present methods, particularly in those who have generalized metastases or carcinomas in inaccessible locations. However, it is very interesting to note the various physiologic changes that take place with cold therapy.

As I understand the basis of cryotherapy, it is that due to the fact that carcinoma cells are young, immature cells, they are more sensitive, that is less resistant to the effects of physical methods, and certainly cryotherapy is a physical method. We do not know that certain changes take place in these cells which in some instances can be demonstrated histologically, as very ably demonstrated by Drs. Fay and Smith of Temple University. Also certain changes probably take place in all of the physiologic processes of the body.



I was very glad that Dr. Mueller brought out the fact of combining deep X-ray therapy with cryotherapy. Perhaps at the lower body temperatures the carcinoma cells will be more sensitive to X-ray. This method deserves further study.

Although I am rather optimistic with reference to the future of medicine we do not expect to cure hopeless cases of carcinoma. Perhaps at present we should be satisfied if we merely relieve pain or prolong life which in itself is an accomplishment. However, with further improvements in apparatus and technic, together with further scientific research, cryotherapy may reveal many important advantages for future consideration.

In our work, under the direction of Dr. Disraeli Kobak, we use refrigerated air circulating through variously shaped thin rubber bags instead of water or other liquids for both internal and external topical therapy. I would strongly urge that instead of being adverse to such an interesting physical method as cryotherapy, we all continue further with an open mind until study gives us the proper direction. It is naturally hoped that cold therapy in itself or combined with other physical or chemical methods may lead us toward a solution to that dreaded disease, cancer. Further, it may prove to be a valuable adjunct to the treatment of other human ailments, such as infections, inflammations and the like.

**Dr. M. K. Newman** (closing): Dr. Mueller has noted some interesting effects with artificial lowering of body temperatures. Mental patients, especially schizophrenics, have been given large doses of insulin to produce a state of unconsciousness. An unusual observation has been made, namely, that some patients develop a reduction in body temperatures as low as 90 F. In our series, an obese patient with a metastatic breast carcinoma, treated with artificial refrigeration for twenty-four hours, did not show the slightest lowering of body temperature. Perhaps the only suggestive sign was a mod-

erate degree of comfort. One cannot predict the direction which future uses of cold treatment may take. It might be possible to carry out a more successful reduction of temperature with the use of insulin, at least in obese individuals.

The fact that local application of cold is known to produce a necrobiosis and disintegration of the local mass suggests its clinical use in cancer therapy. However, the effects seem to be quite superficial and temporary. One patient in our series had a diffuse carcinomatous involvement of the bladder. Following three weeks of continuous cold therapy, biopsy sections failed to show any lesion. However, at autopsy several months later, there was a superficial destruction of the malignancy with a diffuse infiltration of the bladder wall.

Dr. McGuinness' remark about the pathologist not finding any pathological evidence of regressive changes is quite apropos. Drs. Smith and Fay of Temple University have pathological proof of the effect of local cold on tumor tissue. They find the cancer tissues undergoing regressive changes, and at the same time note the formation of new blood vessels and healing.

I want to thank Dr. Louis Newman for the encouraging view that he takes with respect to this phase of physical therapy experimentation. Unfortunately the newspapers have given the layman an idea that a new cancer cure is at hand. All we are trying to do is to learn what effect low body temperatures have on the physiology of body activity and its possible application in a therapeutic sense to malignant tumor states.

Dr. King can get more information from Dr. Oppenheimer who did circulation time studies at Temple University.

Within the next five years we should have at hand an adequate amount of physiologic studies on the effect of hypothermic states on body activity. Then, and only then, will or will not the application of "refrigeration therapy" achieve a status comparable to that of fever therapy.



# THE EFFECT OF ARTIFICIAL FEVER UPON LIVER GLYCOGEN \*

LUCILLE LOSEKE, M.D.

and

MILLARD F. GUNDERSON, Ph.D.

Department of Pathology and Bacteriology, University of Nebraska,  
College of Medicine, Omaha

OMAHA

In studying the effect of artificial fever upon rabbits, it was observed that the blood sugar rose with an increase of the animals' temperature. Since the fever did not cause dehydration, it was improbable that the increase in the blood sugar was not due to a reduction in the water content of the blood. An additional feature of the same tenor was the fall in the leukocyte count after hyperthermia. For this reason it was resolved to estimate the amount of glycogen in the liver of rabbits which had been subjected to artificial fever.

Nine animals were so used and killed immediately in order to obtain the liver for glycogen determination. Four control animals were also killed. The liver was removed and the glycogen content estimated. Animals used in this work had the same preliminary care as rabbits used in the previous experiments. Their last feeding was at the regular meal time the day before the experiment.

In this connection it may not be amiss to point out that Jacobsen, Hosoi, and Kiyoshi<sup>1</sup> used a special histologic technic to detect the effect of artificial fever upon liver glycogen in animals and found that the liver glycogen was decreased. Some of the liver tissue which they examined contained no demonstrable glycogen, but quantitative estimations of the actual amount of glycogen present were not made.

Histologic changes in the parenchymatous organs produced by artificial fever have also been studied by von Haam.<sup>2</sup> He found both depletion of glycogen and degenerative changes in the liver, but he noted that the areas of degeneration and glycogen depletion were not identical. There were areas of necrosis in the liver in which the glycogen was not depleted.

## Methods

Blood sugar determinations were made of the blood of all the rabbits used. Both Folin-Wu tungstate blood filtrates and Somogyi zinc filtrates were used to estimate the true sugar values. According to Somogyi<sup>3</sup> the zinc filtrates give the true sugar values of the blood, while with other filtrates the sugar values are made higher by the presence of non-sugar reducing substances which are not precipitated by tungstic acid. Somogyi has checked the validity of these statements by fermentation tests in which the non-reducing substances can be quantitatively estimated after the sugar in the blood filtrate had been fermented.

The animals were killed by a blow on the head in the early part of the afternoon. This time was chosen because it was known that the rabbits which had fever would also be killed at that time of day after having received five hours of heat. The liver was immediately taken from the animals and placed in the hot 60 per cent solution of potassium hydroxide. The entire operation from the time the rabbit was killed and the liver was dropped into the hot caustic solution did not exceed one minute. The mixture was placed in a hot water bath and

\* This work was made possible by the Fever Therapy Research fund.

boiled for three hours in order thoroughly to digest the liver. Pflueger's<sup>4</sup> method for glycogen extraction and hydrolysis was used.

### Animal Observations

*Blood Sugars.* — The difference between the true sugar values from the zinc filtrates and the tungstic acid filtrates varied from 6.4 mg./100 cc. to 8.25 mg./100 cc. for rabbits G-8, G-10, and G-11. In the case of Rabbit G-9 whose initial blood sugar was high there was a difference of 29.9 mg./100 cc. of blood. The blood sugar data is found in Table 1.

TABLE 1. — *Blood Sugar Determinations on Different Filtrates From Blood of Untreated Rabbits*

Rabbit	Blood Sugar Folin-Wu Filtrate	Blood Sugar Somogyi Filtrate	Difference
G- 8	111.1	104.7	6.4
G- 9	152.6	122.7	29.9
G-10	95.2	86.95	8.25
G-11	95.2	86.95	8.25

*Glycogen Determinations.* — Since the glycogen had all been hydrolyzed to glucose, the values are given in terms of the number of Gm. of glucose in 100 Gm. of liver. They are expressed as percentage values. The amount of glucose multiplied by the factor 0.927 gives the amount of glycogen in Gm. per cent of the liver. The livers of rabbits G-8 and G-11 were high in glycogen while the amount present in the other two rabbit livers corresponded to the average values found by other workers. (See table 2 for liver glycogen determination in the four normal rabbits.)

TABLE 2. — *Liver Glycogen Estimations of Untreated Rabbits*

Rabbit	Glycogen as Glucose Gm./100 Gm.	Actual Glycogen Gm./100 Gm.
G- 8	5.19	4.82
G- 9	2.27	2.20
G-10	1.975	1.92
G-11	3.925	3.81

Table 3 contains a record of the blood sugar of those rabbits that had preliminary fever applications before they were killed.

TABLE 3. — *Blood Sugar Estimations Before and During Fever Treatments*

No.	Initial Value			2.5 Hours			5 Hours		
	Folin Wu	Somogyi	Dif.	Folin Wu	Somogyi	Dif.	Folin Wu	Somogyi	Dif.
G-12	122.09	106.95	15.14	131.5	116.2	15.2	156.8	142.8	14.0
G-13	109.2	105.2	4.0	180.8	133.0	47.8	285.7	251.5	34.2
G-14	52.5	50.0	2.5	Blood Clotted					
G-15	88.1	83.2	4.9	Rabbit Died					
G-16	116.2	97.5	19.7	232.0	208.3	24.7	Died		
G-17	102.5	89.2	13.3	178.5	166.6	11.9	Died		
G-18	109.8	93.1	16.7	150.9	141.8	9.1	245.4	239.5	5.9
G-19	131.1	119.4	11.7	207.2	192.3	14.5	266.6	233.9	32.7
G-20	112.9	112.04	0.86	275.86	272.1	3.76	Died		

*Blood Sugars.* — The animals which had preliminary fever applications showed the rise in blood sugar. The difference between tungstate and zinc filtrate blood sugar values in mg./100 cc. is very inconsistent, as is seen in table 3.

The amount of glycogen found in the liver tissues after rabbits had been given artificial fever is recorded in table 4.

TABLE 4.—*Liver Glycogen Estimations of Rabbits Killed After Five Hours of Artificial Fever*

Rabbit	Glycogen as Glucose Gm./100 Gm.	Actual Glycogen Gm./100 Gm.
G-12	2.0	1.854
G-13	2.24	2.08
G-14	0.0	0.0
G-15	0.377	0.347
G-16	0.0	0.0
G-17	3.43	3.18
G-18	0.12	0.111
G-19	0.124	0.115
G-20	0.132	0.121

*Liver Glycogen.* — In considering the liver glycogen measured in terms of glucose, a decrease of glycogen is generally noticeable in the liver of those rabbits which had had fever. The livers of Rabbits G-14 and G-16 contained no detectable glycogen according to our methods, while the glycogen content of the liver tissue of most other rabbits was greatly reduced. With the exceptions of G-12, G-13, and G-17 in which the evidence of decreased glycogen is rather indefinite, none of the livers of rabbits which had had been subjected to fever contained as much glycogen as these from untreated rabbits.

### Discussion

Several causes for the rise of blood sugar during fever may be surmised. The factors which may be concerned are: the effect of stimulation by the nervous system; the possible effect of asphyxia, and the effect of hormones such as insulin and adrenalin. Another possible factor is the rise in the metabolic rate. Furthermore, the initial high blood sugars in some instances may be due to excitement of the animals caused by handling them and tying them down. In the case of excitement, however, the stimulation of the rise in blood sugar is due to the effect of the nervous stimulation upon the glycogenic function. Stagnation in the blood stream caused by fever promotes vasodilation, increases capillary permeability, and the resulting tissue asphyxia may stimulate the adrenal glands. This is the opinion of Freeman, Morrison, and Sawyer.<sup>5</sup> On the other hand, the increased metabolic rate creates a greater need for available glucose in the blood stream. This causes either stimulation of the nervous system or some effect upon the hormonal mechanism by which the glycogen is broken down to glucose to supply the metabolic tissue requirements.

In case of fever, unexpected demands for larger quantities of glucose in the blood are made because of the increased metabolic rate. Bischoff, Maxwell, and Hill<sup>6</sup> have made studies upon the phosphates of whole blood during hyperthermy and report that the inorganic phosphates of the whole blood decrease during that state. From this it is concluded that glucose utilization increases for inorganic phosphorus of the blood stream decreases when glucose utilization in the tissues increases. Somogyi<sup>7</sup> explains the phenomenon in the following manner. Since the rate of glucose utilization increases during fever, the rate of glycogen breakdown in the liver is increased to such an extent that it overshoots its mark and results in hyperglycemia. In other words, the glycogenolytic function of the liver is overstimulated. With this overstimulation the glycogen of the liver is depleted. Somogyi found ketosis to be an effect of hyperthermy, and from this as from the increase of blood sugar he inferred depletion of liver glycogen.

Hasch<sup>8</sup> found that blood sugar levels were higher during acute febrile conditions and thought that toxic products were formed which caused this effect. He noticed that sugar tolerance in acute febrile diseases resembled diabetic curves.

Voit<sup>9</sup> observed increased metabolism and a subsequent rise in the protein destruction in the body during fever. He explained the increase in the protein metabolism as due to the quick combustion of glycogen. He thinks the increased protein destruction is due to carbohydrate depletion in the cells and suggests the ingestion of protein and carbohydrates during fevers to prevent cell destruction. Von Haam, who studied the effects of fever upon animal tissues, found areas of necrosis in the liver which were not depleted of glycogen and other areas of glycogen depletion with no degenerative evident changes.

The fact that in most instances the non-sugar reducing substances were present in small amounts is evidence that the high sugar values obtained in the blood of treated animals was not caused by an increase in the non-sugar reducing substances. Glutathione, thionine, and creatinine are three of the substances in the blood which are non-sugar reducing substances. Somogyi says their total may equal 20 per cent of the total reducing substances as determined by ordinary blood sugar methods. As seen in table 3, often when the blood sugar values were very high the non-sugar reducing substances were lower than at previous lower blood sugar readings. This may perhaps be explained by the observations of Gentile and Scozzari<sup>10</sup> that the total amount of glutathione in the blood remains unchanged during experimental hyperthermy, but the amount of reduced glutathione decreases while the amount of the oxidized form increases.

### Summary and Conclusions

1. In these experiments it has been demonstrated that the liver glycogen is depleted during artificial hyperthermy — an effect apparently directly resulting from the elevation of blood sugar.
2. The blood sugar rises during artificial fever, while the non-sugar reducing substances show no consistent change.
3. The liver glycogen is decreased during artificial fever.

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# ARCHIVES of PHYSICAL THERAPY

OFFICIAL PUBLICATION AMERICAN CONGRESS OF PHYSICAL THERAPY

## .. EDITORIALS ..

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### THE PRACTICE OF MASSAGE IN CALIFORNIA — A CHALLENGE

The legislative body of the State of California is about to pass on a bill promulgated and high pressured by the Massage Operators' Guild of California, which if invoked threatens not only to introduce a dangerous precedent inimical to the health of its citizenry but to create a deadly wound to one of its potential treasure-streams, its undeveloped but fabulously rich natural Spas. From those who have the vantage of experience with similar situations both here and abroad, there has arisen deep concern and pessimism at the blindness of any commonwealth or country that would attempt to trade its economic and vital resources for the glamour of such a pot of porridge. So far as massage itself is concerned no one can appreciate its value more nor wish to condone its abuses less than do we who have carried its torch throughout the ages. No one can speak with greater authority, experience and tolerance regarding its possibilities and limitations than organized medicine, because it was she who contributed greatest to its present recognition and classic tradition. Thus physicians have been the first to sing its praise but not the last to condemn its abuses; for like other therapeutic measures massage is not a panacea for all ills but rather an adjuvant measure of incomparable value when used only under medical supervision.

Thinking minded persons within the medical profession have accordingly voiced deep alarm regarding the evil and vicious implications of this bill introduced into the January, 1941, legislative session of the State of California, for the ostensible purpose of regulating and governing that heterogeneous group practicing massage in that commonwealth. This situation is especially unfortunate and untimely because no other State more than California should be so keenly aware of all the benighted practices that have tended to gravitate within its borders in the name of therapy. The evidence against the past failures of uncontrolled, unsound and unscientific massage and hydrotherapy is today so rich in detail that no one can plead ignorance of the serious consequences bound to arise from a situation that invariably must develop when as now, avaricious forces have combined to promulgate the practice of massage (and hydrotherapy) as an independent discipline for the cure of disease. The evil arising whenever greed and legislative sentimentality combined to foist on an uninformed public some form of practice that by itself was either clearly unscientific or at best an adjuvant procedure, forms the tragic and bizarre chapter in the history of the conflict between charlatanry and conservative medicine. Every age has written its epitaph over the grave of some departed ism, but the healing power of nature and the optimism of life constantly encourage the sprouting of new and deleterious weeds that calls for vigilance and restriction by those historically informed.

It is unfortunate not only for California but for the entire nation that a glorious State so richly endowed with natural resources which scientifically exploited could prove of greatest benefit to countless sufferers, is again becoming the cynosure of the intelligent and conservative forces in our land. The reason for this lies in the sad fact that California for a long time has proved the most attractive stamping ground for all sorts of twilight prac-

tioners and cultists imposing upon an uncritical public weird and downright dangerous therapeutic measures. Instead of watching with Argus eyes to protect the health of the commonwealth it has been claimed that the State offers many opportunities for the legalization of so-called professions that cannot stand the test of truth or even efficiency.

The present bill beyond any question is an attempt to secure legalization for massage under the cloak of which is hidden a sister measure — hydrotherapy. Stripped of all verbiage the bill amounts to no more and no less than the creation of a board of several men supposedly experienced in the ordinary routine of massage to control its practice. What is of even greater importance is the potential danger contained in the bill of placing into the hands of so-called masseurs control over California's vast medical treasures with which that State has been so richly endowed by beneficent Nature. No other country or state on this hemisphere has locked within its boundaries such unexploited wealth to be obtained from its mountains, thermal springs and vast ocean expanse in the form of hydriatic measures commonly grouped as hydrotherapy.

Lest it be misunderstood, there can be no question that both measures in themselves have full recognition by the organized medical profession, nay scientific medicine itself, as therapeutic methods, but with this proviso that like nursing they must be applied only when indicated and then in a manner not to cause serious harm. The question naturally suggests itself, who is qualified to determine such indications and the manner of application? No indication can be established without a thorough and exact diagnosis in order to avoid potential dangers resulting from what to many uninitiated may appear as an extremely simple procedure. The literature is replete with unfortunate cases of deep seated infection or cancerous growths or inflammatory processes of joints due to gonorrhea, syphilis or tuberculosis that have been treated with massage by non-medical personnel with grave or even fatal results. Is the State of California thoughtlessly going to authorize and legalize a body of rubbers to ply their trade without medical control? Are the intelligent members of the House of Representatives and of the Senate of California so uninformed or naïve as to create a new and independent craft which throughout the civilized world has at no time been permitted to function without the control of the medical profession? Do the legislators not realize that a person, no matter how well versed in giving rubs or putting persons in the bathtub, is utterly unable to recognize a vast number of diseases which tax the very ingenuity of experienced and qualified physicians and surgeons equipped as they are by long training and with clinical and laboratory facilities of the highest order? Is it to be presumed that the legislators by mere enactment of a bill can transform men with a smattering of the merest premedical fundamentals into full fledged diagnosticians? Whenever such assumptions have in past occasions permitted indigenous practitioners of the ancient art of massage to exploit this field without rational restrictions from the medical profession, it invariably gravitated to the lowest level and made it the butt of all the ironic and satiric quips of a laughing world. Who hasn't heard the witty sally: "I'd rather lie in the arms of Massage than fall into her hands"? Who doesn't squirm at the satiric epitaph erected over the imaginary grave of this practice: "Here lies Massage — as usual"?

It is quite true that there are professions allied to scientific medicine that in most States of our Union have secured recognition. Nurses, dietitians, physical therapy technicians and others have obtained official status, but in no instance have they had the temerity to demand the right

of independent action and practice on their own responsibility. Yet men with far less training than they, hope to utilize the law making power of a State to grant them a privilege due only under the law both written and unwritten, to men who after an adequate education have toiled many years in colleges, laboratories and hospitals before being granted professional recognition.

Another danger that the passage of the bill under discussion implies, is that three non-medical men constituting the massage board may under the wording of that bill feel justified in arrogating to themselves professional control over the valuable and vast hydriatic resources with which California has been blessed by a benevolent Nature. To illustrate our point, let us ask who is going to advise a patient seeking the benefits of a California Spa, the board of massage of graduate bath rubbers or the highly trained physician in charge of the institution? Is there not danger of causing injustice to the economic welfare of the State of California when a high pressure minority group is placed in the position to exert real or imaginary power to the end of possible control of the spas? Accordingly we ask the solons of California to consider the weal of the masses rather than the privileges of a few self-seekers and to afford protection to their fellow citizens by defeating this vicious bill.

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#### OCCUPATIONAL THERAPY ASSOCIATION TO MEET WITH THE CONGRESS

The Congress and the American Occupational Therapy Association again will join forces to render their next annual conventions of greater mutual interest. Both organizations which have so many scientific and other interests in common have agreed to hold their conventions in Washington in The Mayflower on September 1, 2, 3, 4 and 5 next.

While the two bodies will present their own programs wholly independent of each other, it is believed that there will be ample occasion for an exchange of thoughts, so that members of the American Congress of Physical Therapy will have all the privileges including that of discussion from the floor, the same facilities being accorded the members of the American Occupational Therapy Association. This arrangement is believed to be especially propitious and timely because of the present interest of all concerned in the rehabilitation of war casualties. While it is sincerely hoped that the American people will aid in the preservation of human liberties by giving every moral and material assistance to the defenders of democracy without having to go to the extreme of actual participation in battle, we must nevertheless be prepared for any contingency, as citizens and as physical therapists, so that any and all forms of rehabilitation should receive our full attention.

As was already stated both programs will be carried out independently, but plans are under way to arrange some social and scientific joint sessions.

Further details will be announced in this section of the ARCHIVES and it is suggested that all who plan to attend our next annual convention and to contribute to the combined programs should communicate with our Executive Director, Dr. Walter J. Zeiter, at the Cleveland Clinic, Cleveland, Ohio, or with the Executive Secretary of the Congress at our Chicago office.

# SCIENCE, NEWS, COMMENTS

## Physical Therapy Section of New York State Medical Society Annual Meeting

Tuesday, April 29, 1941 — 10 A. M.

Hotel Statler, Buffalo, New York, Room 306.

Chairman: Madge C. L. McGuinness, M.D., New York.

Secretary: Harold J. Harris, M.D., Westport.

1. The Significance of Muscular Balance in Acute Disorders of Posture and Locomotion. *Henry H. Jordan, M.D., New York.*

2. Therapeutic Relaxation. *Jerome Weiss, M.D., Brooklyn, and Hans J. Behrend, M.D., New York.*

3. Ultraviolet Irradiation of Autotransfused Blood in the Treatment of Acute Infections. *George P. Miley, M.D., Philadelphia.*

4. The Role of Spas in Medical Preparedness. *Walter S. McClellan, M.D., Saratoga Springs.*

Discussion: George G. Martin, M.D.; Joseph A. E. Syracuse, M.D.; E. W. Rebbeck, M.D., and Allen W. Holmes, M.D.

## Dr. Kotkis Honored by Missouri State Medical Association

Dr. A. J. Kotkis has been appointed as Chairman of the Special Committee on Physical Therapy of the Missouri State Medical Association, by Dr. Cyrus E. Burford, President. The personnel of the Committee is as follows:

C. A. W. Zimmerman, M.D.; Frank L. Feierabend, M.D.; William J. Stewart, M.D., and John L. Washburn, M.D.

## New York Physical Therapy Society

The New York Physical Therapy Society will hold its stated meeting, Wednesday, March 12, 1941 at 8:30 p.m. at the Hospital for Joint Diseases, entrance 45 East 123rd Street, New York, N. Y.

The following program is planned:

### I. Scientific session:

1. Manipulation and Its Place in Therapy. *Thomas R. Thorburn, M.D., (by invitation).*

2. Technique for Reduction and Ambulatory Treatment of Sacroiliac Displacements. Demonstration and lantern slides. *Willard Travell, M.D., and Janet Travell, M.D., (by invitation).*

General discussion.

Closed meeting for members only.

### II. Executive Session — Impending Legislation.

## The New Jersey Society of Physical Therapy Physicians' January Scientific Meeting

The monthly session of the New Jersey Society of Physical Therapy Physicians was held in Essex County at the Academy of Medicine of Northern New Jersey in Newark, on January 30, 1941. Two

scientific papers were presented. The first, "Electricity in Medicine, Part One," was offered by Dr. Eugene Charbonneau, of East Orange, a pioneer in physical therapy. Dr. Charbonneau's paper stressed the clinical value of static electricity, and also delivered a scholarly review of low frequency currents in therapy. The second paper, "The Combined Physiotherapeutic and Medical Management of the Allergic Syndrome," was presented by Dr. Robert F. Dow, of Paterson. It emphasized the physical findings in allergy, and showed the ameliorating influence of ultraviolet and short wave diathermy on the allergic episodes.

## Lectures on Infantile Paralysis at Vanderbilt University Sponsored by National Foundation for Infantile Paralysis

In April a series of six lectures on Infantile Paralysis by outstanding medical authorities will be presented at Vanderbilt University, Nashville, Tennessee. These lectures are sponsored by the National Foundation for Infantile Paralysis, Mr. Basil O'Connor, President of the Foundation, announced.

Dr. Ernest W. Goodpasture, head of the Department of Pathology at Vanderbilt is supervising the arrangements and said that eminent authorities from all parts of the country would be brought to the University to give the lectures which have been designed to cover thoroughly the entire field of the disease.

The schedule as arranged by Dr. Goodpasture is as follows:

April 7, Monday, The History of Poliomyelitis (Progress of the knowledge of the disease up to the present), by *Paul F. Clark, Professor of Bacteriology, University of Wisconsin School of Medicine;*

April 8, Tuesday, The Etiology of Poliomyelitis (Including its relation to diagnosis), by *Charles Armstrong, Senior Surgeon, U. S. Public Health Service;*

April 9, Wednesday, Immunity to Poliomyelitis (Including Serum, Therapy and Vaccination), by *Thomas M. Rivers, Director, Hospital of the Rockefeller Institute for Medical Research;*

April 14, Monday, Pathology and Pathogenesis of Poliomyelitis, by *Ernest W. Goodpasture, Professor of Pathology, Vanderbilt University School of Medicine;*

April 15, Tuesday, Epidemiology of Poliomyelitis, by *John R. Paul, Yale University School of Medicine;*

April 16, Wednesday, Treatment and Rehabilitation of Poliomyelitis Patients, by *Frank Ober, Assistant Dean, Harvard University Medical School.*



The lectures will be held in the amphitheatre of the Vanderbilt Medical School at 8 o'clock each evening, and are open to all interested persons. Invitations are being issued to the faculty of various universities, members of medical associations, and others.

In announcing the lectures, Mr. O'Connor further stated they will be so designed and prepared that they will serve as the material for a publication by the National Foundation, intended to constitute a recent survey of the field of Infantile Paralysis.

"They will also compose a critical review, with bibliography that should be useful as a stimulating educational production, as well as a work of reference for those contemplating or engaged in any investigative work," he said.

### International Medical Club of New York

Dr. Foster Kennedy, Professor of Neurology, Cornell University Medical School will address a joint meeting of the International Medical Club of New York with the French, Hispano-American, Hungarian-American, Italian, Rudolph Virchow and Russian Medical Societies, on Wednesday, March 5, at 8:30 P. M. in the amphitheater of the New York Polyclinic Medical School and Hospital, on "Contributions of Foreign Graduates to American Medicine." This meeting is the first of a series of gatherings intended to bring together metropolitan medical men of all races and nationalities, in order to promote a better appreciation of the international cultural aspects of medicine and to foster unity in upholding American ideals. In the United States it is still possible that a physician of British extraction may address a gathering of medical men of Italian and German extraction and that they all work harmoniously with those of Russian, Spanish and Hungarian origin for the common ideal of serving mankind.

### Identity of New B Vitamin Is Now Announced

Identity of a new B vitamin, needed by rats to keep their hair from turning gray, is announced by Dr. S. Ansbacher, of the Squibb Institute for Medical Research (*Science*).

This member of the vitamin B complex is p-aminobenzoic acid. Besides its role in preserving hair color in black and piebald rats, the vitamin is needed by chicks and bacteria for growth.

Human importance of this vitamin at present probably attaches less to its effect on hair color than to its action on sulfanilamide. Dr. Ansbacher points out that last year D. D. Woods and P. Fildes, in England, reported that in test tube experiments the vitamin, or acid, nullifies the action of sulfanilamide in checking growth of hemolytic streptococci. This seems to raise the question, for medical scientists to answer, whether doses of vitamin B complex which many people are now taking should be stopped during sulfanilamide treatment. — *Science News Letter*.

### Radio Interference Found With Portable Receiver

Radio interference can be quickly located with a new portable radio receiver especially designed for such service. It can also be used to locate underground pipes. Self-contained batteries, or the regular A. C. or D. C. power lines can be used to run it. (*Sprague Products Co., North Adams, Mass.*) — *Science News Letter*.

### Making Calcium Gluconate Speeded by Research

Calcium gluconate, valuable drug in the care of expectant and nursing mothers and of other persons needing quick additions of calcium to their blood, can be produced more rapidly and cheaply as a result of new researches by scientists of the U. S. Department of Agriculture.

Until a few years ago, calcium gluconate could not be used in medicine because of its excessive cost. Then Department chemists discovered that certain strains of mold, fed upon glucose solution, could produce commercial quantities of gluconic acid at a very low cost. Added to calcium carbonate, in the form of common chalk, it converted that compound into the valuable calcium gluconate.

The most practicable production procedure is to grow the mold in sheets in slowly rotating drums, through which air is forced, for the respiration of the mold plants. Difficulties were encountered when the gluconic acid concentration piled up, retarding the fermentation process. Chalk added at this stage resulted in the formation of a good deal of unsolved calcium gluconate, clogging up the drum.

The difficulties were resolved when three Bureau of Agricultural Chemistry researchers, A. J. Moyer, E. J. Umberger and J. J. Stubbs, discovered that the addition of a little borax or boric acid to the fermenting liquid keeps the calcium gluconate in solution and lets the molds finish their work. Later, the gluconate may be separated from the solution, free from boron.

By removing the solution from time to time, the same mold growth may be used over and over again. Efforts are now being applied to the problem of making the process continuous instead of semi-continuous, and thus further reducing the cost of making calcium gluconate. — *Science News Letter*.

### Tuberculosis Picked Up By Pigs From Chickens

It is very bad for pigs to let chickens stray into their pens, the U. S. Department of Agriculture warns.

Not that the hogs are henpecked. But chickens are carriers of avian tuberculosis, to which swine are more susceptible than the fowls themselves. This has been proved in experiments carried out by sci-



entists of the Bureau of Animal Industry, at the Beltsville, Md., Research Center.

Fifty chickens and 31 hogs, all reacting negatively to the standard tuberculin test, were penned with 50 chickens known to be tubercular. They were kept together for a year, when the tuberculin test was repeated. Positive reactions were obtained from 93.5 per cent of the hogs, whereas only 54 per cent of the previously nontubercular chickens reacted.

The remedy, Department scientists point out, is obvious and simple. Keep all chickens, even apparently healthy ones, severely away from the pigpens. — *Science News Letter*.

### Photoelectric Cell Drops Headlight Screen

Polarizing screens to eliminate automobile headlight glare have been talked about for some time, though they would greatly reduce the efficiency of the lights. To avoid this, an inventor proposes that a photoelectric cell be placed on the front of the car. When another car approaches, this "electric eye" operates a mechanism to lower the screens into place, so that they only operate when needed. (Patent No. 2,230,262, Leon Pollack, Brooklyn.) — *Science News Letter*.

### Two Stage Electronscope Will Increase Magnification

Though the electron microscope, which takes pictures with electrons instead of light, has already been used to make magnifications as high as 25,000 times, a new method of using it may even increase its power.

This method was described to the American Physical Society by Dr. W. V. Houston, and Hugh Bradner, of the California Institute of Technology. They use the microscope in two stages.

First, electrons come from a filament similar to an electric lamp. These are focussed by an electrical lens on a thin film which is to be magnified. The electrons passing through are then focussed again by two magnetic lenses, either on a photographic plate, or a screen made of materials which glow with electron bombardment, and thus make the image visible. — *Science News Letter*.

### Masks for Surgeons Can Be Made of Paper

Masks for surgeons, as well as for workers in dusty atmospheres, are made of paper, with a vegetable fiber that is insoluble in live steam, boiling water or common solvents. When soiled they can be washed, or discarded. (Aldine Paper Co., N. Y. C.) — *Science News Letter*.

### Newest of the Vitamins Tested by Germ

A germ related to the one that turns milk sour has given scientists a simple test for one of the newest of vitamins, pantothenic acid.

Details of the test, which can be used for determining the amount of this vitamin in foods or the abundance or lack of it in a patient, were reported by Dr. F. M. Strong, R. E. Feeney and Ann C. Earle of the University of Wisconsin Col-

lege of Agriculture to the American Chemical Society.

New knowledge of human requirements of this vitamin may be obtained more quickly now that this test is available.

At present the amount of this vitamin in various foods has been estimated by feeding it to chickens. This requires several chickens and two or three weeks to test each sample of food. The lactic acid germ, however, also needs pantothenic acid and the amount it gets from any particular food can be determined within a day by determining the amount of acid the germ produces.

The new test is said to be extremely sensitive as well as simple, and its speed appears from the report that 10 to 15 samples of food can be tested, or assayed, for pantothenic acid content in a day. — *Science News Letter*.

### Ontario Dental Association

The 74th Annual Convention of the Ontario Dental Association will be held at the Royal York Hotel, Toronto, Ontario, May 19, 20, 21, 1941. Dentists from the United States and from all parts of Canada will be welcome.

### Blood Transfusion Given by Bones Instead of Veins

Blood transfusions can be given through the bones as well as through the veins, Dr. L. M. Tocantins and Dr. J. F. O'Neil, of Jefferson Medical College and Hospital in Philadelphia, have found.

In 17 trials of this method on 14 patients there was one failure, they report to the Society for Experimental Biology and Medicine.

Substances injected into the bone marrow enter the blood stream apparently unchanged and almost as rapidly as when injected into the veins, they report.

Bones will not supplant veins as a route for introducing blood or other substances into the bodies of patients. In some conditions, however, it is difficult or impossible to inject into the veins. Widespread mutilations, burns, dropsy, shock, and poorly developed or obliterated veins are conditions in which the bone transfusion route might prove vitally useful. In little babies the veins are usually so poorly developed that injections into them are difficult or impossible.

Blood is not the only substance that can be given through the bones as well as through the veins. Sugar solutions for patients whose blood sugar has reached dangerously low levels; blood plasma which is now being used as well as whole blood for transfusions, and salt solutions to maintain the necessary amount of fluid in the bodies of patients too sick to even drink water, may also be injected through the bones.

The blood or other substances are injected into the marrow of the bones where blood cells are formed, and presumably make their way into the blood stream as the blood cells do. The breast bone, collar bone, thigh bone and shin bone were used for the injection in the cases reported by the Philadelphia scientists. — *Science News Letter*.

### Interesting Facts

Pale colors are fashionable in Britain—they require less dye.

An airplane engine may contain more than 8,000 separate pieces of metal.

A process for making artificial wool from peanut meal has been patented.

All eggs laid by one hen are likely to be of similar size, shape, and color, with minor variation.

The U. S. Bureau of Mines has contrived a mechanical house shaker, to study vibration hazards that blasting causes to nearby buildings.

Had the population of the United States continued growing as it did up to 1900, there would be 150,000,000 people now instead of about 131,000,000.

To aid in advancing cultural relations, the U. S. Bureau of Mines is lending technical motion pictures from its large film library to Latin American countries.

Europe furnished the capital for the plantation system in the New World, Asia provided sugar cane, Africa the laborers, and America the climate and soil, says Dr. Leo Waibel in the Scientific Monthly.

When Napoleon was exiled on St. Helena, the British stationed Hottentot soldiers on Tristan de Cunha, 1,500 miles farther south in the Atlantic, lest Napoleon's friends use this island as a base for a rescue.

England is employing more men and fewer women, a trend attributed to evacuation of women to outlying areas.

A simple self-watering device for houseplants devised at Cornell University works like a kerosene lamp—a wick draws water from a container below the plant up to the soil.

Great depth of the Mediterranean Sea is a factor that facilitates submarine attack.

South America's transcontinental railroad, 2,500 miles long from Santos, Brazil, to Arica, Chile, is being pushed to completion with 425 miles under construction and 378 yet to be started.

### Danger in Benzedrine

For reviving those who have passed out after imbibing moderate amounts of alcohol, benzedrine is effective and relatively safe. But this wake-up drug may be dangerous when more than moderate amounts of alcohol have been taken.

This is the conclusion that may be drawn from experiments on rabbits reported in New Orleans to the Federation of American Societies for Experimental Biology by Dr. E. C. Reifenstein, Jr., of Syracuse (N. Y.) University.

Benzedrine (technically, amphetamine sulphate) has been known previously to be useful for sobering-up. It is used also in preparations for relieving stuffy noses. And recently it was reported useful for treating nervous patients and even problem children.

Dr. Reifenstein's rabbit experiments show that the drug has no restorative effect after lethal amounts of alcohol and even increases the toxicity of near lethal quantities of alcohol.

Alcohol, in rabbits at least, counteracts the effects of amphetamine, protecting the animal against lethal doses of the drug. This finding may prove valuable in cases of nervous and emotional disturbances, such as the sleep disorder, narcolepsy, for which amphetamine is proving a valuable remedy. If patients under this treatment should get an overdose of amphetamine, the antidote, apparently, would be a cocktail. — *Science News Letter*.

### New Muscle Strength Test

Results with a spring-scale muscle tester and recording device for determining accurately the actual power of paralyzed muscles was reported by Dr. A. A. Schmier of The Hospital for Joint Diseases.

Practically all the muscles of the legs and arms can be accurately evaluated by use of this new device, while the strength of the muscles concerned with the motion of the trunk and pelvis can be measured by a swivel table with a gravity principle scale devised by Dr. Leo Mayer and associates at the same hospital. — *Science News Letter*.

### Cancer-Causing Stuff Found

A cancer-causing substance (or substances) accumulates in the livers of patients suffering from cancers in other parts of their bodies. Suitably extracted and prepared, it is capable of producing new cancers when injected into mice.

Such is the announcement, possibly heralding an important new advance in the scientific understanding of cancer (and hence its ultimate control) by Dr. Paul E. Steiner of the University of Chicago.

The chemical nature of the substance is still unknown, but Dr. Steiner states that he is at work on this, as well as on the questions of its origin and its distribution within the body.

In one of his experiments, the Chicago researcher started with approximately two pounds of liver tissue, obtained from persons who had died of cancer in five different organs, but none of them involving the liver. After repeated extractions with a strong alkali, there was left a flaky, brown, ill-smelling residue. Dissolved in sesame oil and injected in small quantities into the bodies of mice, this produced typical cancerous tumors in a convincing number of cases.

Elaborate control experiments were performed, to eliminate the chance that the new cancers might be arising from some other cause, but in every case the indications pointed back to the brown liver extract as the most probable cause. Further intensive research is now in progress. — *Science News Letter*.

### Patent on Invisible Glass

Two patents, Nos. 2,220,861 and 2,220,862 were granted to Dr. Katharine B. Blodgett, physicist of the General Electric Company, for the "invisible glass" which she invented, and which has attracted

a great deal of scientific attention in the past year or two. Both patents were assigned to her employers.

The first is for the method of treating a glass surface with a film, its thickness equal to one-quarter of the wave-length of the light falling on it. With such a thin film, the surface reflects practically no light, but it all passes through. Many applications are possible in optical instruments, such as photographic lenses, periscopes, range-finders, etc., to increase their efficiency by eliminating wasteful reflections of light between the various lenses.

Films prepared in this way are easily rubbed off. The second patent provides a means of making this permanent. Thin layers of glass containing metals, thus increasing their power to bend light rays, are fastened to both sides of a sheet of another kind of glass. By chemical treatment of the outer layers of the sandwich, a durable film, with the proper reflection-reducing properties, is formed on their surfaces. — *Science News Letter*.

### Chromosomes Increased by Chilling of Eggs

Animals with three times the normal number of chromosomes in their cells were reported by Dr. Raymond B. Griffiths of Princeton University to the American Association of Anatomists meeting in Louisville. The animals were newts, which are long-bodied, tailed relatives of frogs and toads. Dr. Griffiths was able to produce specimens with the triple chromosome count by chilling their eggs at temperatures a few degrees above freezing. He also obtained newts with half the normal chromosome number by the same chilling technic. — *Science News Letter*.

### Blood Cancer Transmitted by Virus-Like Substance

Further evidence that the cancer group of diseases can be caused by viruses or virus-like substances in the body fluids was presented to the American Association of Anatomists by Drs. Arthur Kirschbaum and Kurt G. Stern, Yale University School of Medicine. They were able to transmit leukemia, which is a kind of blood cancer involving wildfire growth of white corpuscles, from diseased chickens to previously healthy fowl, by injections of blood.

Then they separated the blood into fractions of differing molecular weights by whirling it in an ultracentrifuge until it had been subjected to a force of 67,300 times gravity for half an hour. They found that the heavier fractions had high leukemia-causing capacity, while the lighter portions had little ability to transmit the disease. In physical and chemical properties the leukemia-causing portions of the blood were found to resemble a cancer-causing extract previously obtained by ultracentrifuging cultures of a chicken tumor. — *Science News Letter*.

### Dr. William E. Montgomery 1885-1941

It is with sorrow that we record the death of Dr. William E. Montgomery of Pueblo, Colorado. Dr. Montgomery was born in 1885 and graduated from the University of Oklahoma School of Medicine in 1911. In 1917 he was licensed to practice medicine.

### Effect of the Galvanic Current On Paralyzed Muscle — Molander, et al.

(Continued from page 160)

14. Wolfson, H.: Studies on Effect of Physical Therapeutic Procedures on Function and Structures: 1—Effect of Blood Flow in a Normal Limb, *J. A. M. A.* **96**:2019 (June 13) 1931.
15. Cook, D. D., and Gerard, R. W.: Effect of Stimulation on Degeneration of Severed Peripheral Nerve, *Am. J. Physiol.* **97**:412 (June) 1931.
16. Tinel, J.: *Nerve Wounds*, New York, Wm. Wood & Co., 1918.



## THE STUDENT'S LIBRARY

EEN OMWENTELING IN DE BEHANDELING VAN SUIKERZIEKTE. De Causale Diabetestherapie. (A Guide to the Treatment of Glycosuria. The Etiologic Therapy of Diabetes.) By Dr. *Jules Samuels*, Surgeon-Gynecologist. Head of the Institute for Short Wave Therapy. Amsterdam. Cloth. Pp. 167 with illustrations. Leiden: E. J. Brill, 1941.

In the past few years no individual has so challenged the profession with claims and assertions regarding the diagnostic and therapeutic possibilities inherent in certain physical agencies as has Samuels. Within the past few years the international literature has listed twelve articles and five books from his pen, which indicates a fertility and energy of a quality that by now should have been adjudicated by the English speaking profession. Throughout these years Samuels has submitted the thesis that certain endocrine disturbances, or diseases associated with a disturbed endocrine background, could be diagnosed by a comparatively simple *in vivo* method, designated by him as *spectroreductometry*, and that the cure of early cancer and now (in this text) the control of diabetes is within therapeutic reach by radiation of certain glands. It is time that such assertions be met with more than raised eyebrows, supercilious looks or speculative ratiocination. It is time that his work and data be subjected to the microscopic test of truth and not left to silence and time as the reducing agent of all experience. Samuels persistently knocks at the door of scientific medicine for a hearing, and in this instance presents an interesting thesis that a replacement method of substitution therapy as now practiced can be introduced in the form of properly dosed short wave treatment to stabilize and normalize certain of the abnormally functioning glands of internal secretions such as the pituitary, thyrotropic or gonadotropic centers. The proof and reasons for his conclusions are organized into fifteen sections and represent his theories and clinical experiences with the diagnostic and therapeutic methods mentioned. It reviews present knowledge of diabetes, its cause and treatment. It evaluates the present views of the endocrinologic basis of this disease, its symptoms and complications. The author presents twelve clinical cases of diabetes controlled by him with short wave treatment and cites other colleagues who have published a greater number of cases. The circumstance that only physicians abroad and particularly Dr. J. Batory of Osijek of Yugoslavia, have had favorable experience with Samuels' method, precludes the possibility of drawing any authoritative opinions from any American reviewer at this early moment. In the place of experience we can only

offer impressions and these of necessity must be based upon opinions stemming from the literary quality of the work and of the man. Samuels is an earnest enthusiast of his own work and his belief in its future has fired him with a zeal out of proportion to his proof — i.e., proof acceptable by science. Thus his books resemble in style a popular exposition which contains overtures of enthusiasms, beliefs and convictions that cannot in their present form be shared by the sincere but critical workers in medicine. Unquestionably there is a basis of truth in his thesis, but there are facts either so minute or disorganized that one cannot at this time regard them as sufficient to evoke the recognitions hoped for by Samuels unless his claims are confirmed by many in our own land. It would be a boon to English medicine to have this book translated and its contents subjected to critical investigation. The volume offers a series of summaries in English, French and German, but the English version is so linguistically clouded for those attempting to obtain the essence of his teachings that it fails adequately to interpret its objective.

RADIOLOGY PHYSICS. AN INTRODUCTORY COURSE FOR MEDICAL AND PREMEDICAL STUDENTS AND FOR ALL RADIOLOGISTS. By *John Kollock Robertson*, F. R. C. S., Professor of Physics, Queen's University, Kingston, Canada. Cloth. Pp. 270 with 188 illustrations. Price, \$3.50. New York: D. Van Nostrand Company, Inc., 1941.

This work attempts to supply a need in the orientation of students of radiology, namely the position, influence and practical implication of the role of physics in this special medical problem. It has long been realized that much of this important background has become the neglected no man's land in our medical curriculum, and for reasons known only to each school and instructor the teaching of the physics of radiology has been a neglected feature in their instruction program. Professor Robertson has apparently solved this problem, at least to the satisfaction of Queen's University in Canada. Because he found it well-nigh impossible to teach in one year the fundamental principles of physics and at the same time deal adequately with clinical features of this discipline, he devised the plan to give such instruction in two successive years, which proved satisfactory for all concerned. The instruction included general physics for the first year, and (the second year) lectures and laboratory work in electricity and magnetism which naturally lead to consideration of the roles and value of x-ray transformers, radioactivity, nuclear physics, high frequency currents and the like. The text under consideration is with certain amplification the result of such instruction. Its class room success has prompted the author to classify in orderly



or practical sequence the results of his experiences. In the space of 16 chapters and an appendix students and specialists of radiology can now be provided with selected expositions of the fundamental and important data of medical alternating currents as they are related to the production, measurements and control of high voltage currents. An entire chapter is devoted to the place of the cathode rays in x-radiation while other chapters explain the practical import of wavelengths in the field, the construction of tubes, their emission and radiation effects and the like. Space will not permit to evaluate each chapter for the material offered to the special student of this subject. Suffice it to say that here is a contribution that should be of great interest to instructors because of its guidance and teaching value. It is a book that few serious minded students can afford to be without, because it falls in that neglected lacuna in medical radiology seldom touched upon but which is the very material backbone of this discipline.

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**THE POWER OF THE CHARLATAN.** By *Grete de Francesco*. Translated from the German by *Miriam Beard*. Cloth. Pp. 288. With 68 illustrations. Price, \$3.75. New Haven, Connecticut: Yale University Press, 1939.

This artistically printed work in many respects offers a piece of pseudo-medical history, which is unusual in that it not only conveys a good idea of quacks and their brazen and often incredible methods of duping even persons of rank and mind, let alone the credulous masses, but critically reviews the underlying psychologic factors that made such phenomena at all possible, often enough even successful for long periods. Medical histories and certain monographs, notably by Dr. Morris Fishbein, have exposed quackery, but here is a scholarly and specialistic study by an author who has delved deep in the concerned literature and has formed her rich material into a plastic figure. This literary effort is grouped into five sections entitled as follows: The Charlatan: The Man and His Power; Alchemy and Its Charlatans; Power Through Propaganda; The Higher Charlatanry; The Marvels of Technology, a New Form of Magic. Some particularly prominent quacks, such as Thurmeisser, Bonafede Vitali, and Cagliostro are given much space because of the roles they played in their times. The work, being as it is a cultural record, a review of the struggles of science and of enlightened literati and laymen and laywomen (Empress Maria

Theresa of Austria, for example), and a thorough exposé of the ingenuity and brazenness of quacks in civilized countries, not excepting our own, is too rich in detail to be adequately described or evaluated in a brief review. Suffice it to say that anyone interested in the subject from a psycho-historical point of view will derive intense pleasure from its perusal, while literary workers will welcome an extensive bibliography from which the authoress has drawn her material. Illustrations of scenes, pamphlets, self-laudatory portraits and a cut of the hanging of an unmasked charlatan convey an insight into the life of peoples that are so long past. The book originally published in Switzerland merits a place in the libraries of scholars.

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**A MANUAL OF OTOTOLOGY, RHINOLOGY AND LARYNGOLOGY.** By *Howard Charles Ballenger*. Cloth. Pp. 302, with 94 illustrations. Price, \$3.75. Philadelphia: Lea & Febiger, 1940.

This Manual of Otology, Rhinology and Laryngology has been designed to meet the particular needs of undergraduate medical students. The author therefore in a concise manner has emphasized principles of anatomy, etiology, symptoms and diagnosis, and has stressed only the usually accepted general and local treatments. Stylistically this work likewise is well suited to the student's need. The author has made free use of bold faced type to emphasize the subject matter which is presented in a lucid and terse fashion. The work attempts to crowd in all the fundamental facts pertaining to this subject and hence demands the full attention of the reader. The data are so richly knit together that much will be missed unless the student is made aware that the greatest profit will come from only concentrated reading. Illustrations and plates adequately supplement the written text. The twelve colored plates of ear drum pathology are particularly informative. In keeping with the author's policy of supplying an inclusive exposition, chapters covering allergic states and the role of physical therapy in Otolaryngology have been included. In this latter chapter the student will receive a conservative introduction into the possibilities of physical therapy in this field. This textbook by omitting unnecessary theories, questionable medical and surgical treatment maintains its sharp focus to the end. It therefore should be welcome by students, nurses, general physicians and by otolaryngologists seeking convenient reference to a fast developing and important field.





# INTERNATIONAL ABSTRACTS

## **Copper by Iontophoresis. In Treatment of Dermatophytosis. G. O. Gundersen.**

Indust. Med. 9:405 (Aug.) 1940.

Iontophoresis is the term applied to that particular type of electro-chemistry, where the medicinal agent is introduced into the skin in ionic state. In this case copper by means of direct current was used after the method of Haggard Strauss and Greenberg, as described in J. A. M. A., April, 1939. The treatment of fungus infection depends upon the clinical manifestation of the disease. In vesicular, bullous, pustular, macerated, or weeping forms, the best method of approach is with wet dressings of hypertonic saline, magnesium sulphate or boric acid; opening and draining vesicles and pustules and continuing wet dressings until drainage ceases, when antiseptic dressings may be applied. In the types which do not drain, antiseptic applications preferably ointments can be used immediately. The author has found tar dernament, mycozol and merthiolate ointment particularly effective.

In some of the scaling and hyperkeratotic types, Whitfield's ointment or some other of the salicylic acid preparations are best used as an introduction to the regular therapy. In general, the above methods are used by us in the treatment of fungus infections and with good success. The author had six cases which were unusually stubborn on which he used copper sulphate by iontophoresis.

## **The Effects of Carbon Arc Radiation on Blood Pressure and Blood Histamine. Henry Laurens, and Henry von Kolnitz.**

Med. Record 152:209 (Sept. 18) 1940.

Dogs were trained to lie quietly on a table for several hours, during which time control blood pressure readings were taken, blood samples drawn for study of histamine and the animal then irradiated. The dosage of carbon arc radiation varied from 35-75 Gm. cal./sq. cm. although on a few occasions smaller doses (20 Gm. cal.) were given. The results were proportional to the dosage. After irradiation the blood pressure was followed and samples of blood drawn at intervals for the determination of H-like activity. In some instances the procedure was repeated the following day, in most others the animals were not irradiated again for two or three days in order to avoid pigmentation and thickening of the skin. The blood pressure fell following irradiation (two to four hours) and this was correlated with an evident increase in blood H-like activity. The blood samples were drawn usually from a saphenous vein, but on many occasions simultaneous samples were drawn from the femoral artery and femoral, jugular and saphenous veins with no ap-

preciable differences, except in two instances when the jugular samples showed a very significant increase over the corresponding saphenous sample, reaching the value of 0.5 cc. H-like activity as compared with 0.1 cc. for the saphenous sample drawn at the same time. The pre-irradiated value in both was 0.05 cc. In some instances blood was drawn from an irradiated ear as representative of skin blood. The H-like activity of such blood was closely similar to simultaneously drawn saphenous samples. Individual irradiations lowered arterial pressure with a corresponding increase in blood H-like activity. Unfortunately, a continued correlation between lowered blood pressure and increase H-like activity of the blood was not apparent except in a very few instances.

## **Capillary Resistance in Artificially Induced Fever. Philip L. Rossman.**

Ann. Int. Med. 14:281 (Aug.) 1940.

In an attempt to explain the mechanism of hemorrhage in artificially induced fever, studies of capillary resistance by means of the suction test were made on 12 subjects, three of whom were used twice, making a total of 15 observations. The outstanding pathologic observations in experimental animals and human subjects following induced fever have been the presence at autopsy of focal hemorrhages and acute parenchymatous degeneration of the organs.

Rossman observed that induced fever by means of the Kettering hypertherm produced an immediate decrease in capillary resistance as determined by the suction test applied to the skin of the forearm. There occurred a quick return of the skin capillaries to normal resistance, with a temporary hyper-resistance in many instances, following such a treatment. The focal hemorrhages seen at autopsy after artificially induced fever in experimental and clinical subjects may be due to decreased capillary resistance.

The author was unable to determine the exact cause of this decreased capillary resistance but regards vasodilatation and increased intracapillary pressure as the probable underlying factors.

## **Prevention of Infection by Air-Borne Bacteria of Operative Wounds. Deryl Hart, and Randolph Jones.**

J. M. A. Georgia 29:401 (Aug.) 1940.

Following the installation and general use of bactericidal radiation in the authors' operating rooms, the members of the surgical staff have shown an increasing feeling of security from the danger of postoperative wound infections. Whereas before the introduction of the bactericidal radiation unit extensive elective opera-

tions such as thoracoplastics had been deferred until the summer in order to reduce the possibility of wound contamination from the air, at present these operations are performed with greater safety during winter, because not only can the air with its high contamination be sterilized but the perspiration of the summer months is absent. This confidence, brought about by the evident improvement in the general postoperative condition of the patients and the virtual elimination of severe postoperative wound infections, is confirmed by statistical analyses of comparable groups of cases. Using strict asepsis, a meticulous technic, and sterilization of the air with bactericidal radiant energy Hart and Jones have had no deaths from postoperative wound infections in clean incisions and such previously unexplained infections have been all but eliminated.

**Physical Therapy in Arthritis. With Special Reference to Home Treatment. Frank H. Krusen.**  
J. A. M. A. 115:605 (Aug. 24) 1940.

The author reviews the therapeutic possibilities of a variety of physical methods heretofore found useful in arthritis. These are grouped into three major physical measures. The first makes use of heat and cold, obtained most readily through the medium of water; and electrical appliances, such as electric incandescent lamps, infra-red generators and diathermy. The second group takes advantage of certain forms of mechanical manual methods such as massage, manipulation and splinting. The third exploits such procedures as exercise, postural training and rest. Heliotherapy and artificial ultraviolet radiation are recognized as a practical adjuvant, especially when the patient is run down, suffers from secondary anemia and the like. Heat, exercise and rest is the therapeutic trinity advocated by Krusen, especially that form of treatment which is as practical that it could be self administered and so reasonable in cost that it is within the reach of the greatest number suffering from arthritis. His views on rest are interesting. He states: "In . . . arthritis, rest is of cardinal importance during the stage of acute inflammation. If there is pain on movement, marked tenderness, fever or increase in the local temperature of the part, rest, as a rule, is indicated. It should be remembered, however, that such rest should be permitted only with the joint held in a position to prevent contracture and deformity. Furthermore, rest should not be continued indefinitely. As soon as inflammation subsides and the patient starts cautious movement, rest can be discontinued and mobilization started. However, even after inflammation has subsided, joints should be rested in the sense that heavy trauma from weight bearing and other causes should be avoided. Likewise the irritation of repeated movements (wiggling of joints) should be prevented. At the same time that rest is being provided, slow rhythmic movements through the full range of motion in each direction should be attempted once or twice a day. At all times, fatigue should be guarded against. The patient should avoid fatigue rather

than remain at absolute rest. The problem is more one of rest plus mobilization than of rest versus exercise."

**Management of Tetanus With Report of Use of Hyperthermia in One Case. Philip H. Heersma.**

Minnesota Med. 23:636 (Sept.) 1940.

According to the author this method must rest for the present on its merits as a means of symptomatic control of the painful spasms of tetanus which contribute, through exhaustion, the greatest problem and danger of this infection. Relief from the terrifying spasm, even at the cost of any discomfort of the heat therapy was welcomed by the patient and throughout the entire course the patient was able to be more cooperative on smaller amounts of hypnotics than is usually experienced. In addition to these benefits, the more cooperative attitude of the patient is believed largely attributable to his relative freedom from fear and panic during the sessions of fever. For the present, however, the symptomatic relief obtained is sufficient to warrant further trial of this method. There was no doubt of this patient's improvement by the third day of treatment, whereas the clinical course before initiation of hyperthermia was definitely downward.

Some rather intriguing ideas may be offered as the *modus operandi*, such as mobilization of resistive forces and rendering the tissues, containing the toxin, more permeable, permitting increased toxin-antitoxin combination and consequent neutralization. Still another theory is that the heat may produce some of its benefits through other agents. In this regard, it is interesting to note that vitamin C (ascorbic acid) has power to inactivate tetanus toxin *in vitro*. Furthermore, one notes that values of ascorbic acid in blood are unusually low with fever resulting from infection, as well as low in urinary excretion during this period. In other words, in an infection the ascorbic acid demand must be greater and the destruction greater either owing to fever, the infectious agent or both. It does not appear to be borrowing too much to postulate some integral relationship among these factors such as the fever serving to speed up an ascorbic acid reaction of detoxification of the tetanus infection.

**Primary Cortical Centers for Movements of Upper and Lower Limbs in Man. Observations Based on Electrical Stimulation. John E. Scarff.**

Arch. Neurol. & Psychiat. 44:243 (Aug.) 1940.

It has long been commonly accepted in the literature and in the standard textbooks of anatomy that the primary cortical centers for the lower extremity in man were situated on the lateral convexity of the cerebral hemisphere. A critical review of the literature, however, indicates that this concept became established on the basis of a wholly inadequate number of observations made on the human brain—in fact, largely on observations made on the brains of experimental animals.

Observations by electrical stimulation along the superior mesial border of the human cerebrum in 14 consecutive cases indicate that the primary motor area for the upper extremity commonly extends upward on the lateral surface of the cerebral hemisphere as far as its superior mesial border, while the leg, as a rule, is represented only on the mesial surface of the cerebrum.

An upward "migration" of the primary motor strip, unique in man, is implied by the observations reported here. It seems probable that this has been influenced by two factors: (1) "liberation" of the upper extremity from the routine burden of locomotion, with its consequent elaboration of new and highly complex functions, and (2) acquisition of speech and other forms of symbolic expression. These new functional acquisitions have been accompanied by corresponding expansion of the cortical areas representing the tongue, mouth, lips and upper extremity, with the result that the cortical representation for the leg has been crowded farther and farther upward on the lateral surface of the hemisphere until it was finally pushed "over the top" onto the mesial surface of the hemisphere.

Focal contractions of the rectal sphincter, produced by stimulation of the mesial surface of the cerebral hemisphere, are here reported for the first time.

#### Ultraviolet Rays for Air Sterilization in Air Conditioning Systems. Queries and Minor Notes.

Abstract J. A. M. A. 115:1120 (Sept. 28) 1940.

To the Editor:—There has been considerable discussion concerning the use of ultraviolet rays in air conditioning systems for sterilizing the air, particularly because in many systems in which the air is cooled approximately 75 per cent is recirculated from the cooled space, with the possibility that it might carry bacteria. Ultraviolet rays, if used, would be introduced into the recirculated air path, where the velocity may be as high as 1,000 feet per minute. There is a question as to whether such an arrangement would be effective and also a question as to the results that might be accomplished with ultraviolet rays even though the velocity of the air passing the ultraviolet source is not so great. Any information you can supply concerning this matter would be appreciated. —M. D. Wisconsin.

Answer.—Wells, investigator of air-borne bacteria and ultraviolet rays for bactericidal purposes, in a recent publication [J. Franklin Inst. 229:347 (March) 1940] provides much information dealing with the points raised in this query. In a smooth tunnel 100 feet long, the other dimensions being 7 by 8 feet, a standard ultraviolet lamp was set up near the center. At the air entry end of the tunnel, *Escherichia coli* cultures were sprayed into the atmosphere. Various determinations were made as to the killing action of ultraviolet emanations under various conditions, including velocity, humidity and nearness to the lamp. At a velocity of 222 feet per minute and a relative humidity of 43 per cent, when the bacterial count prior to ultraviolet action was 1,250 per sample, a drop to

303 bacteria occurred after passing the rays. At a velocity of 21 feet and a relative humidity of 67 per cent, the count before exposure of 42,000 bacteria dropped to 12,500 after action of the rays.

In another publication [Am. J. Public Health 29:863 (August) 1939] Wells and his associates report some bacterial counts made in an air-conditioned railway car with and without the action of ultraviolet rays in the air conditioning. On this car the passenger load varied from one to sixty-nine. With the ultraviolet rays turned off and a passenger load of one, the total bacteria count was 1,324. When the ultraviolet rays were operating, at a time when the passenger load was fifteen, the lowest reported in this particular series of experiments, the bacteria count was 349, the highest count in this series of samples. When, however, the passenger load was fifty-five the bacterial count was in one sample 186, the lowest figure associated with any passenger load.

From all experimental work, several complex formulas have been devised permitting computations under varying circumstances as to intensity of radiation, air velocity, type of air flow, distance from the rays and the like. The mere introduction of ultraviolet units in the conduits of an air-conditioning system affords no assurance of extensive bactericidal action. Conversely, full consideration for all factors involved might indicate sets of ultraviolet radiating facilities sufficient to cope with any air velocity and bacterial load. The practicability of such equipment under some circumstances is open to debate. Nothing in the publications of Wells as cited suggests that with an assumed velocity of 1,000 linear feet per minute a near-sterile air may be obtained. On the other hand, it is to be recognized that suitable intensities and suitable distribution of ultraviolet lamps in connection with air conditioning will effect some reduction in atmospheric bacterial contamination.

#### Electrosurgical Obliteration of the Gallbladder Without Drainage. (A Report of the Results of 980 Cases with a Mortality of 0.3 Per Cent.)

Max Thorek.

Illinois M. J. 78:211 (Sept.) 1940.

A method of electrosurgical obliteration of the gallbladder is described which, when carefully followed, may be used in simple and complicated cases of gallbladder disease without resorting to drainage. It reduces mortality and shortens hospitalization. The factor of old age loses much of its terrors because shock is usually absent, and because drainage is rendered superfluous and hence is entirely omitted.

Electrosurgical cholecystectomy — electrosurgical cholecystectomy — so-called is a refined procedure wherein the electric cutting knife is substituted for the scalpel. Secondary hemorrhage from the gallbladder bed does not take place in a properly performed electrosurgical obliteration operation of the posterior gallbladder wall because of the tamponade like pressure exerted by the coagulated tissue against the contiguous gallbladder bed.

**Two Point Coagulation. A New Principle and Instrument for Applying Coagulation Current in Neurosurgery. James Greenwood.**

Am. J. Surg. 50:267 (Nov.) 1940.

A new and simple principle of electrocoagulation is presented, for use in securing hemostasis in neurosurgical work. An instrument is described which has been used in applying this method. The essential features of the principle are that the usual body electrode is dispensed with and a forceps is so constructed and used that the current appears only between its tips. Obviously, the closer the tips are placed the smaller the field of electrical activity will be and consequently the smaller the area of tissue coagulated.

The following advantages are claimed: (1) The amount of current necessary to secure hemostasis is less than one-fourth that required by the usual

method. (2) There is less carbonization, tissue dehydration and reaction. (3) There is no shrinking of the blood vessels being coagulated and current is not carried along a blood vessel into deeper tissues. (4) There is no appreciable shrinking of the dura when a vessel is coagulated on its surface or edge nor is there any noticeable effect on the underlying brain. (5) Coagulation is possible under saline and while washing with saline. (6) Cortical incisions may be made through avascular coagulated points on cortical blood vessels, minimal damage being produced in coagulation since current flows only between the forceps tips. Coagulation occurs only in the vessel held and not in the brain tissue which is adjacent. A switching arrangement is presented whereby the old method of coagulation may be resumed instantly should the need arise. It is noted that this method should supplement, not supplant the old connection.

**Side Effects of Short Wave Therapy and Their Prevention — Brugsch**

(Continued from page 144)

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